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ORIGINAL ARTICLES

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EDITOR OF THE MONTH

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APPROVED SCHOOLS FOR OCCUPATIONAL THERAPY TECHNICIANS *

Council on Medical Education and Hospitals of the American Medical Association

NOTE: The duration of the course is expressed in academic years

Name and Location of School	College Affiliation	Duration of Course	Classes Start	Entrance Requirements	Tuition Per Year	Certificate, Diploma,	Graduates in 1947
University of Southern California, 923½ 35th Place, Los Angeles	University of Southern California	2 yrs.	FebSept	Degree	$420	Certificate	22
		5 yrs.	FebSept	High sch.	$450	Cert.&B.S.	
Mills College, Oakland, Calif.	Mills College	3 yrs.	FebSept	Degree	$200	Certificate	....
					$550		
San Jose State College, San Jose, Calif.	San Jose State College	1½ yrs.	Varies	Degree	$ 21	Certificate	10
		3¼ yrs.	Varies	High sch.	$ 21	Degree	
University of Illinois College of Medicine, 1853 W. Polk St., Chicago	University of Illinois	5 yrs.	Feb	High sch.	$152	B.S.	14
University of Iowa, Iowa City, Iowa	State University of Iowa, College of Medicine	5 yrs.	.....	High sch.	$ 85	Cert.&Deg	
University of Kansas, Lawrence	University of Kansas	2 yrs.	FebSept	Degree	$131	Certificate	10
		4 yrs.	FebSept	High sch.	$131	B.S.	
Boston School of Occupational Therapy, 7 Harcourt St., Boston	Tufts College	2 yrs.	Sept	Degree	$500	Diploma	13
		5 yrs.	Sept	High sch.	$450	B.S.	
Wayne University, 4841 Cass, Detroit, Mich.	Wayne University, College of Med., Coll. of Liberal Arts, Coll. of Education	5 yrs.	.....	High sch.	.....	.....	
Kalamazoo School of Occupational Therapy, Western Michigan College of Education, Kalamazoo	Western Michigan College of Education	1½ yrs.	FebSept	Degree	$127	Diploma	20
		4 yrs.	FebSept	1 yr. coll.	$127	Degree	
Michigan State Normal College, Ypsilanti	University of Michigan	5 yrs.	Varies	High sch.	$118	Cert.&Deg.	8
University of Minnesota, Church Street, Minneapolis	University of Minnesota	4 yrs.	.....	High sch.	$360	B.S.	
College of St. Catherine, St. Paul, Minn.	The College of St. Catherine	3½ yrs.	Varies	1 yr. coll.	$210	Degree	4
Washington University School of Medicine, St. Louis	Washington University	3 yrs.	Sept	2 yrs. coll.	$400	Degree	10
University of New Hampshire, Durham	Univ. of New Hampshire	5 yrs.	Sept	High sch.	$160	Cert.&Deg.	6
Columbia University College of Physicians and Surgeons, 630 W. 168th St., New York City	Columbia University	1½ yrs.	Sept	Degree	$450	Certificate	28
		2½ yrs.	Sept	2 yrs. coll.	$450	Degree	
New York University School of Education, 100 Washington Sq. E., New York City	New York University	4½ yrs.	FebSept	High sch.	$500	Cert.&Deg.	20
Ohio State University, Columbus	Ohio State University	3 yrs.	Quarterly	High sch.	$105	Degree	21
Philadelphia School of Occupational Therapy, 419 S. 19th St., Philadelphia	University of Pennsylvania	1½ yrs.	Sept	Degree	$500	Diploma	35
		3 yrs.	Sept	1 yr. coll.	$500	Diploma	
		.....	.....	High sch.	$600	.....	
Texas State College for Women, Denton, Tex.	Texas State College for Women	5 yrs.	FebSept	High sch.	$150	Degree	13
Richmond Professional Institute, 901 W. Franklin St., Richmond, Va.	Medical College of Virginia	1½ yrs.	Sept	Degree	$200	Certificate	20
		3 yrs.	Sept	1 yr. coll.	$200	Certificate	
College of Puget Sound, Tacoma, Wash.	College of Puget Sound	3 yrs.	FebSept	Degree	$350	Certificate	
		5 yrs.	FebSept	High sch.	$300	Cert.&Deg.	
University of Wisconsin, Madison	University of Wisconsin	4 yrs.	FebSept	High sch.	$320	Cert.&Deg.	8
Milwaukee-Downer College, Dept. of Occupational Therapy, 2512 E. Hartford, Milwaukee	Milwaukee-Downer College	2½ yrs.	Sept	1 yr. coll.	$300	Diploma	22
		4 yrs.	Sept	High sch.	$300	Dipl.&Deg.	
Mount Mary College, 2900 Menomonee River Dr., Milwaukee		Varies	Sept	Degree	$335	Certificate	15
University of Toronto, Dept. of University Extension, Toronto, Ont., Canada	University of Toronto	5 yrs.	Sept	High sch.	$260	B.S.Deg.	
		3 yrs.	Sept	1 yr. coll.	$222	Diploma	110
Colorado Agricultural and Mechanical College, Fort Collins, Colorado		5 yrs.	Sept	High sch.	.....	B.S.	

* Rep. in part J. A. M. A. 137:1460 (Aug.) 1948.

THERMAL GRADIENTS DURING VARYING BODY TEMPERATURES

With Particular Reference to Changes During the Application of External Cold in Patients with Noninfectious Fevers *

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NEW YORK

Homeothermic man normally maintains his body temperature within narrow limits departure from which renders him ill, and life itself becomes impossible when his temperature varies too far from the norm. Accordingly, man must retain within his body a certain amount of heat and yet dissipate daily the 2,000 to 5,000 kilogram calories which his metabolism produces. No single temperature defines his body heat content. Heat is produced in the tissue and is dissipated at the skin surface and to a lesser extent from the lungs. The result is a series of thermal gradients extending from the hot core to the cooler skin and usually summed in the over-all gradient of rectal temperature to skin temperature. Of his many temperatures, it is the deep tissue temperature, represented by the rectal temperature, which is most important to body function and which is normally maintained at the homeothermic norm by compensating mechanisms. The other body tissues, particularly the skin, adjust their temperatures in such a manner as to keep the deep tissue temperature normal.

When the critical rectal temperature rises to such a degree that the temperature itself becomes a harmful agent, its reduction becomes desirable and even imperative. The most effective means of reducing the elevated deep tissue temperature has been the focus of many observations and considerable difference of opinion.[1] Usually cooling of the skin has been utilized. It is considered to extract heat from the deep tissues in either or both of two ways: (*a*) by conduction between deep and peripheral tissues, a slow and inefficient process, and (*b*) by direct extraction of heat from blood perfusing the cooled skin, a more rapid and efficient process. Various methods of skin cooling have been advocated, based on how well they avoid cutaneous vasoconstriction. In its essence, the question resolves itself into whether cold can be applied to the skin in febrile states without causing cutaneous vasoconstriction and interfering with the extraction of heat directly from the cutaneous blood flow. As a corollary there remains the question of the best method of application of various cooling agents.

During a study of the distribution of heat in the body and the manner of its flow over the various thermal gradients, an opportunity arose to observe

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* This study was supported by a grant from The Baruch Committee on Physical Medicine.

* Read in part at the Twenty-Fifth Annual Session of the American Congress of Physical Medicine, Minneapolis, Sept. 6, 1947.

1. (*a*) Gauss, H., and Meyer, K. A.: Heat Stroke: A Report of 158 Cases from Cook County Hospital, Chicago, Am. J. M. Sc. 154:554 (Oct.) 1917. (*b*) Wilcox, W. H.: The Nature, Prevention and Treatment of Heat Hyperpyrexia: The Clinical Aspect, Brit. M. J. 1:392 (March) 1920. (*c*) Morton, T. C. St. C.: The Aetiology and Treatment of Heat Exhaustion and Heat Hyperpyrexia, with Special Reference to Experiences in Iraq, Proc. Roy. Soc. Med. 25:1261-1271 (June) 1932. (*d*) Fantus, B.: Therapy of Disturbances Due to Heat, J. A. M. A. 103:990-991 (Sept.) 1943. (*e*) Saffert, C. A.: Heat Hyperpyrexia: Report of Extreme Case Surviving 8½ Days, Minnesota Med. 20:106-108 (Feb.) 1937. (*f*) Ferris, E. B., Jr.; Blankenhorn, M. A.; Robinson, H. W., and Cullen, G. E.: Heat Stroke, Clinical and Chemical Observations on 44 Cases, J. Clin. Investigation 17:249-262 (May) 1938. (*g*) Borden, D. L.; Waddill, J. F., and Grier, G. S. III: Statistical Study of 265 Cases of Heat Disease, J. A. M. A. 128:1200-1205 (Aug. 25) 1945. (*h*) Nayer, H. R.: Comment on Article Statistical Study of 265 Cases of Heat Disease by Borden, Waddill, and Grier, ibid. 129:1123 (Dec. 15) 1945.

the changes in tissue temperatures during fever and during attempts to lower it by various cooling means. Some of these observations are here reported.

Subjects and Methods

This presentation is limited to observations on patients with fever of noninfectious origin. These fevers were chosen with the thought that they might be of simpler origin and more readily resolved in terms of physical imbalance between heat gains and heat losses to the body. Most subjects had central nervous system disorders, chiefly delirium tremens and agitated psychoses; a number had cerebral vascular lesions; the remainder had fever of unknown cause.

The observations were made largely during the summer months in warm environments, ranging from 76 to 90 F. as extremes, with most observations in "still" air at 80 to 84 F. All subjects were supine in bed and completely nude except for a small loin cloth. During the observations most patients were quiet, at most only very mildly active. Agitated patients were confined with wrist and ankle restraints and were rendered quiet by previous sedation (usually sodium amytal and paraldehyde). Observations were made at all hours of the day and without reference to food; usually many hours had elapsed since the last meal. In some instances patients were receiving fluids intravenously or by hypodermoclysis and penicillin intramuscularly during the observations.

All temperatures (rectal, muscle, subcutaneous, skin surface) were measured by copper-constantan thermocouples. The rectal thermocouple consisted of one copper and one constantan wire, each gauge 30, carried by an applicator 2½ inches beyond the anal orifice. The skin thermocouple likewise consisted of one constantan and one copper gauge 30 wire, drawn over the open end of a plastic test tube which became the applicator by which the bare thermal junction was applied to the skin. Muscle and subcutaneous thermocouples were constructed of one gauge 42 copper wire and one gauge 30 constantan wire threaded through gauge 22 hypodermic needles, 1½ inches long, with the wires soldered at the needle tip. Electrical potentials at the thermal junctions were determined by a Rubicon type 2703 potentiometer and converted to temperatures by the use of calibration coefficients determined under conditions reproducing those in which the thermocouples were used. This precaution is particularly important in regard to skin temperature, where different coefficients became necessary, and were determined, for the different environmental temperatures.

Skin temperatures were determined in turn from twelve individual areas: back, back of thigh, cheek, chest, abdomen, upper arm, forearm, palm, thigh, calf, dorsum of the foot, and toe. These individual temperatures were integrated into a single average skin temperature (T_s) by a weighting formula based on that developed by Hardy and DuBois.[2] Muscle temperatures were determined at a depth of 1½ inches, usually in the anterolateral aspect of the thigh. Subcutaneous temperatures were measured in the same region, with the needle introduced as for a hypodermic injection but tunneled for its full length (1½ inches) just beneath the skin.

Sweating was determined by the starch-iodine test using Minor's[3] solution applied in spots to areas adjacent to those from which skin temperature was determined, plus the axilla and groin. Transparent scotch tape applied over a portion of each "spot" increased the sensitivity of the test in the detection of minimal amounts of sweating. This precaution was necessary because with minimal sweating evaporation from the skin occurred before the water of the sweat could produce the starch-iodine reaction. When the spots were covered, these minimal quantities of water were trapped to give the blue starch-iodine reaction. As an index of hydration, the plasma protein, hematocrit and hemoglobin values were determined by the copper sulfate method.[4] Pulse and respiratory rates were counted and the blood pressure determined by the ausculatory method.

Results

Relation of Skin Temperature to Rectal Temperature. — Normally an increase in body heat content causes a rise in deep tissue (rectal) temperature (T_r) which calls forth an increase in skin temperature (average) (T_s), to-

2. Hardy, J. D., and DuBois, E. F.: The Technic of Measuring Radiation and Convection, J. Nutrition 15:461-475 (May) 1938.

3. Minor, V.: Ein neues Verfahren zur klinischen Untersuchung der Schweissabsonderung, Deutsche Ztschr. f. Nervenh. 101:302, 1927.

4. Phillips, R. A.; Van Slyke, D. D.; Dole, V. P.; Emerson, K., Jr.; Hamilton, P. B., and Archibald, R. M.: Copper Sulfate Method for Measuring Specific Gravities of Whole Blood and Plasma; with Line Charts for Calculating Plasma Proteins, Hemoglobin, and Hematocrit from Plasma and Whole Blood Gravities, New York, Josiah Macy, Jr., Foundation, January, 1945.

gether with sweating. Even small rises in rectal temperature will induce large increases in skin temperature and marked sweating. Generally further increases in rectal temperature produce further increases in skin temperature. In the febrile patients here studied this was not the case, and there was no consistent relationship between rectal and skin temperature over a wide range of rectal temperatures (chart 1). The average skin temperature was just as high, or low, in patients with high degrees of fever as in those with

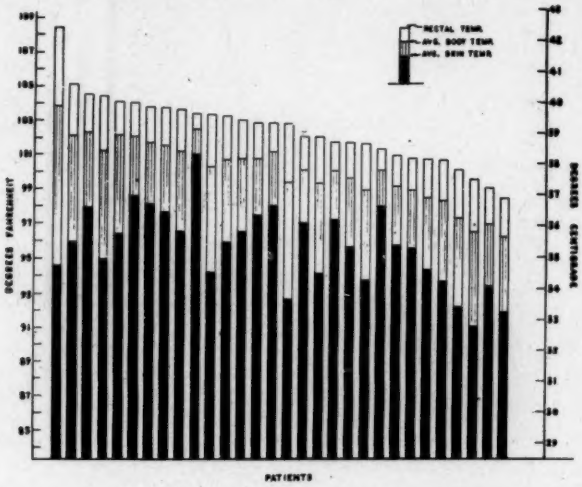

Chart 1. — Relationship of average skin temperature (T_s) to rectal temperature (T_r) and average body temperature (T_b) in patients with noninfectious fevers. Each column represents 1 patient.

low fevers or after defervescence. Since the room temperatures during these observations were not identical, some variation of skin temperature is to be expected but the differences in room temperature probably did not account for the (observed) pronounced variations in skin temperature.[5] Furthermore, the relationship of average skin temperature to body heat content[6] was no better and skin temperature appeared not necessarily to be determined by either the deep tissue temperature (T_r) or the total heat content of the body.

Generally, when the skin temperature was high and the rectal-skin temperature gradient low, there was evidence of cutaneous vasodilatation and an increased blood flow to the skin (chart 2, *A*). The high temperatures of the hands and feet indicate this. When the skin temperature was relatively low and the rectal-skin temperature gradient high, there were indications of cutaneous vasocontriction with a reduced blood flow to the skin (chart 2, *C*). The low temperatures of the hands and feet were evidence of this vasoconstriction; at times associated with peripheral circulatory failure (shock), at other times not. In other patients intermediate skin temperatures were observed. With these differences in cutaneous blood flow and skin temperature, at times even at the same rectal temperature in the same patient

5. Based on the observations of DuBois relating skin temperature to environmental temperature in normal subjects (Hardy, J. D., and DuBois, E. F.: Regulation of Heat Loss from the Human Body, Proc. Nat. Acad. Sc. 23:624 (Dec.) 1937).

6. The heat content of the body is the product of the average body temperature (T_b), body weight and specific heat of body tissue ($T_b \times$ wt. $\times$ sp.h.). Since in a given subject the weight and the specific heat are constant, the average body temperature (T_b) may serve as an index of body heat content. It was deemed to be of no advantage to calculate heat content in calories, since the accuracy could be no better than T_b. Average body temperature was calculated from the following formula (from Burton, A. C.: The Average Temperature of the Tissues of the Body, J. Nutrition 9:261 (March) 1935):

$$T_b = 0.67\ T_r + 0.33\ T_s$$

where

T_r = rectal temperature
T_s = weighted average skin temperature
0.67 = weight of body considered at rectal temperature.
0.33 = weight of body considered at skin temperature.

(chart 3), it would seem unlikely that the response to the external application of cold would be the same for all febrile subjects.

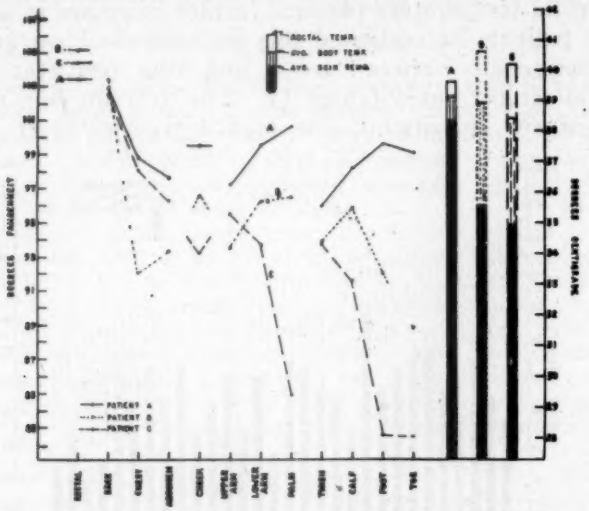

Chart 2. — The skin temperatures of various areas of the body surface in 3 patients with noninfectious fever and the relationship of their average skin temperature to their rectal and average body temperatures. The individual points (connected by lines) indicate the temperatures of the eleven separate skin areas indicated on the abscissa.

Cooling Through the Periphery (Skin). — Studies were made during attempts to lower the deep tissue temperature and the body heat content by the application of cooling agents to the skin. The application of ice to the

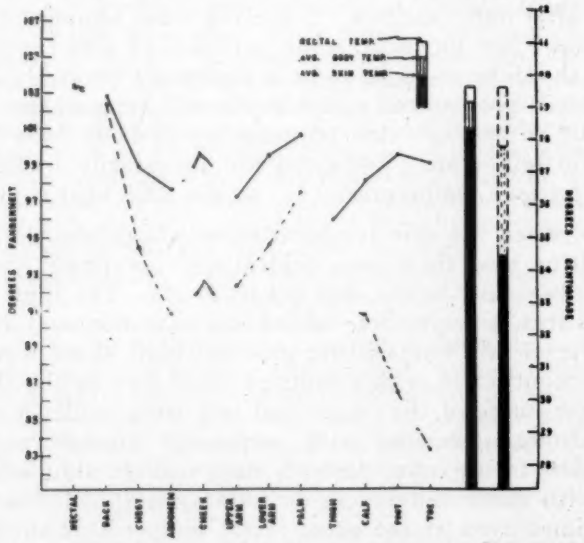

Chart 3. — Differences in the skin temperatures of various areas of the body surface and in the relationship of average skin temperature to rectal and average body temperatures on two occasions in the same patient with noninfectious fever.

skin of febrile patients frequently induced the response indicated in chart 4. During the period of "icing" there was a sharp drop in skin temperature (both local and average) with the cooling extending to a less degree into the subcutaneous tissues but not as deep as the muscle at a depth of 1½ inches. The deep tissue (rectal) temperature remained unaltered. Since the peripheral tissues were cooled but the deep tissues were not, blood flow

into the cooled peripheral tissues must have been markedly reduced during the period of active cooling. As a result, extraction of heat from the blood, and thus from the deep tissues, did not occur. At the same time, the failure of the rectal temperature to fall in the presence of a cold skin indicates that deep tissue cooling by conduction must be very slow indeed. After the removal of the ice, the skin temperature rose progressively and returned toward

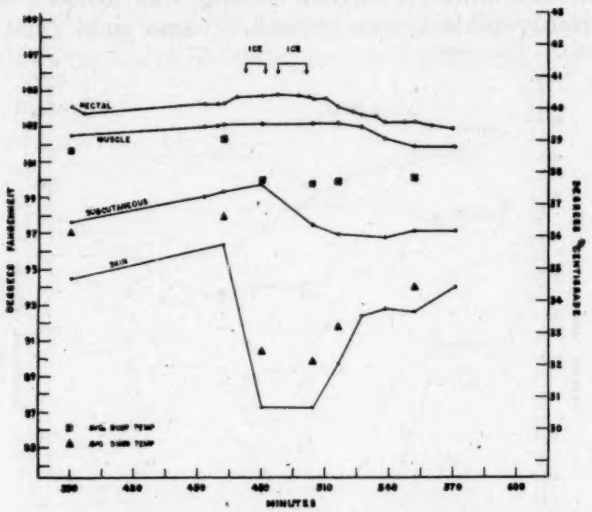

Chart 4. — Effect produced on the thermal gradients between deep and superficial tissues by the application of ice to the the body surface of a patient with noninfectious fever. In this chart and charts 5, 6 and 7 the crosses indicate calculated average body temperature and the triangles calculated average skin temperature. The muscle, subacutaneous and skin temperatures are of the anterolateral aspect of the thigh.

its previous level. Concomitantly there occurred a fall in deep tissue temperature, both rectal and muscle. Apparently, with the cessation of "icing" and the removal of its vasoconstricting influence, blood flow returned to the skin. In the cold skin the blood was cooled, and as it circulated back into the deep tissues it extracted heat from them, with a subsequent fall in their temperatures.

If one utilizes the rectal temperature (T_r) as an index of deep tissue temperature, the average skin temperature (T_s) as an index of the peripheral tissue temperature and the average body temperature (T_b) as an index of the body heat content, then it seems that by the time the "icing" was completed a certain amount of heat had been extracted from the body[7] and that the body heat content remained unchanged at this lower value thereafter (chart 4), even though the rectal temperature fell and the skin temperature rose. This indicates that the late fall in rectal temperature was merely the result of a redistribution of heat between the deep and the peripheral tissues, with some of the deep heat being transferred to the periphery, permitting of a fall in deep tissue temperature. In other words, during the active cooling a certain amount of heat was removed from the body but it was removed almost wholly from the peripheral tissues, leaving the temperature of the critical deep tissues unaltered. With the cessation of cooling and restoration of blood flow to the skin, the ensuing redistribution of heat now permitted the deep tissue temperature to fall and benefit from the heat removal brought about by the "icing."

The proponents of intense cooling of the skin have maintained that it is

7. The assumption is made that the partition coefficient of 0.67 and 0.33 for T_r and T_s, respectively still hold, even though the skin has been cooled.

effective only when blood is kept in the skin, where it can be cooled, and have recommended friction for this purpose. The effects of vigorous rubbing of ice over the skin of a febrile subject is indicated in chart 5. Since this patient was already sweating profusely, evaporative and convective cooling was first instituted. A considerable drop (0.5 degree C., 0.9 degree F.) in rectal temperature at first resulted, but when the temperature leveled off at 105.2 F. for twenty minutes, further cooling was deemed necessary. The skin was vigorously rubbed with ice and became pink. The skin and sub-

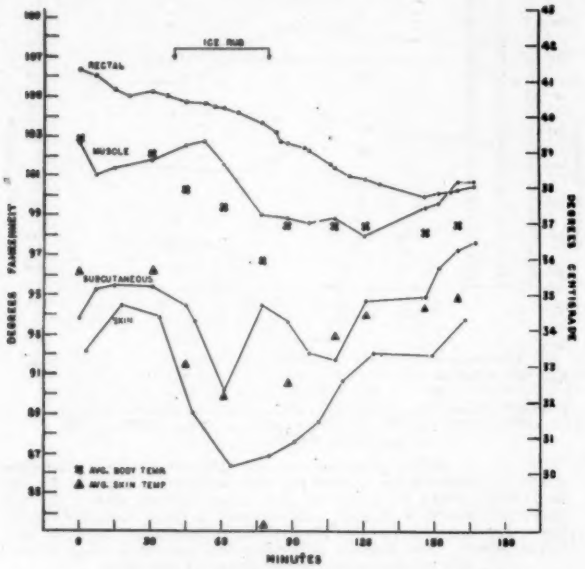

Chart 5. — Effect produced on the thermal gradients between deep and superficial tissues by vigorously rubbing with ice the body surface of a patient with noninfectious fever.

cutaneous temperatures fell sharply and, after some lag, the muscle and rectal temperatures showed similar, though less marked, falls (chart 5). After forty minutes of this cooling procedure, the rectal temperature had fallen 0.8 degree C. (1.5 degree F.), and further cooling was discontinued. There then followed the same sequence of events already described. The skin and subcutaneous temperatures rose; the fall in muscle temperature leveled off; the rectal temperature continued to fall throughout and achieved a decrease of 2.0 degrees C. (3.6 degrees F.) below that at the time when active cooling was stopped. If the changes in body heat content (T_b) are again considered in relation to rectal (T_r) and average skin (T_s) temperatures, the same reduction in body heat content during the active cooling is found. Again, most of this heat was withdrawn from the peripheral tissues with, in this instance, some heat loss from the deep tissues. After the "icing," body heat content again remained unaltered at its lower level while the skin temperature rose and the rectal temperature fell. This fall in rectal temperature was, again, a matter of the redistribution of heat between the deep and peripheral tissues, presumably due to the return of blood into the cool skin with the resultant extraction of heat from the blood and thus from the deep tissues.

Apparently friction during the active cooling did permit the cold skin to be perfused by some blood from which heat was extracted, with resulting moderate lowering of the deep tissue temperature. However, much of the blood must have left the skin, and really effective cooling of the deep tissue

did not occur until after the cessation of the "icing" and the return of blood to the cold skin.

Parenthetically, a pink skin, when it is cold, does not necessarily indicate a good blood flow. First, a cold skin has a low oxygen demand, and, second, below 10 C. oxyhemoglobin fails to dissociate its oxygen and blood will remain bright red. Such blood in the skin may give it a red color, even though the blood flow is poor.

Many observers have maintained that any intensely cold agent applied to the skin will do what these observations have indicated — drive blood out

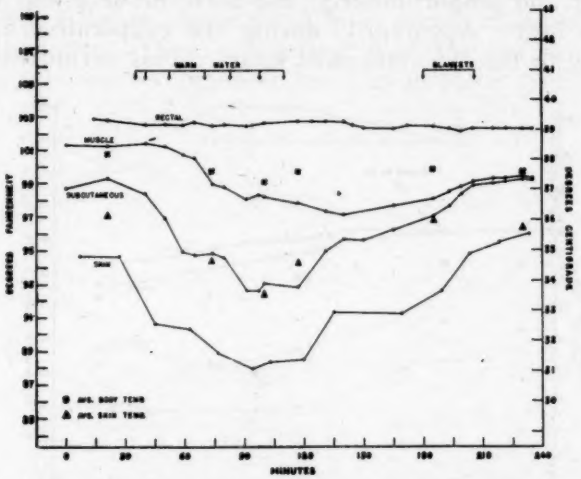

Chart 6. — Effect produced on the thermal gradients between deep and superficial tissues by the evaporation of water at skin temperature from the body surface of a patient with non-infectious fever.

of the skin and thus prevent effective cooling of the deep tissues. They have advocated evaporative cooling, maintaining that the heat loss through evaporation is great (0.59 Kg. cal. per cubic centimeter of water evaporated) and that the less intense cold thus applied to the skin does not induce cutaneous vasoconstriction with its undesirable effects on deep tissue cooling. That these aims are not always attained is indicated by the experience illustrated in chart 6. Water at 34 to 36 C. (approximately skin temperature) was repeatedly applied to the skin and evaporated by a brisk breeze. The evaporative cooling lowered the skin temperature, and the cooling extended inward to reduce the temperature of the subcutaneous tissue and even of the muscle. The rectal temperature did not change. When the evaporative cooling was stopped, the skin and subcutaneous temperatures returned to their previous levels; the muscle temperature returned more slowly and only partially, but the rectal temperature remained practically unchanged, with at best a trifling fall. The changes in body heat content were limited to the peripheral tissues. (The same type of result, in which only the peripheral tissues are cooled without effect on the deep tissue temperature, was at times also encountered during cooling by ice applied to the skin.) The fall in body heat content during the evaporative cooling was small when compared to that induced by ice. This may have been a factor in the failure of the rectal temperature to fall significantly. At any rate, in this instance evaporative cooling conducted so as to reduce to a minimum the vasoconstricting stimulus of cold to the skin apparently failed to prevent such vasoconstriction and blood did not perfuse the skin to be cooled with a resultant lowering of deep tissue temperature.

For comparison in this regard, chart 7 indicates the thermal gradients

during the lowering in rectal temperature produced by acetylsalicylic acid. This patient had a hot, dry skin with almost no sweating. After ingestion of 1.0 gm. of acetylsalicylic acid by mouth, sweating appeared and concomittantly the skin and subcutaneous temperatures fell moderately. Lagging only briefly behind the fall in these peripheral tissue temperatures, the muscle, and then the rectal, temperatures also fell and continued to decrease progressively even after the skin and subcutaneous temperatures had ceased to fall. In general, the deep tissue temperatures fell concomittantly with rather minor falls in peripheral tissue temperatures. The body heat content fell progressively and proportionately, and both the deep and the peripheral tissues gave up heat. Apparently, during the evaporative cooling of the sweat blood flow to the skin remained intact. This permitted the blood to

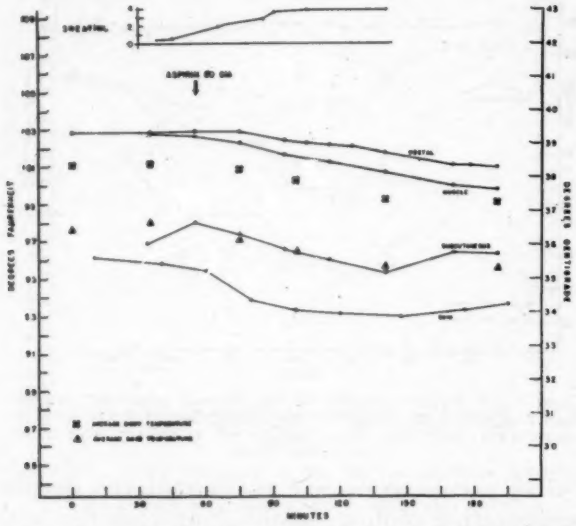

Chart 7. — Effect produced on the thermal gradients between deep and superficial tissues by 1.0 Gm. of acetylsalicylic acid orally in a patient with noninfectious fever.

be cooled directly, and, with an adequate blood flow to ensure a rapid distribution of heat, all tissues shared in the temperature reduction as the heat was being removed at the periphery (skin).

Two clinical examples of the undesirable lag in the reduction of rectal temperature by the application of cold to the skin are indicated in chart 8. The data for these 2 patients were obtained from ward records of the treatment. In both patients the first effect of the application of ice to the skin was a further rise in the rectal temperature. In patient A the high rectal temperature (over 108 F.) was sustained during one hour and forty minutes of active cooling before it began to fall, and in patient B the hyperpyrexia was maintained for one to one and one-half hours in spite of vigorous cooling of the skin. Both patients showed precipitous drops in rectal temperature after the lag period, reminiscent of the sharp falls in rectal temperature seen during the redistribution of heat which occurs when blood flow returns to the cold skin. In patient A, pilomotor activity and chilliness developed during the active cooling and for this reason it was stopped, even though the rectal temperature was 102.6 F. Blankets were applied to patient B when his temperature fell precipitously to 97.6 F. Patient B recovered. Patient A died approximately fourteen hours after her temperature was found to be 108.2 F. The duration of her hyperpyrexia (rectal temperature above 108 F.) was only a little over two hours.

Comment

On the basis of skin temperatures and rectal-skin temperature gradients, two rather distinct types of patients with noninfectious fever have been encountered; one with a cool, either moist or dry skin; the other with a hot, and usually dry, skin. In each the deep tissue (rectal) temperature may be so high that its reduction is desirable, or even imperative, and cooling measures become necessary. A simple consideration (usually not undertaken) of the skin temperature and of the skin circulation will indicate that any single cooling method applied to the skin may not be suitable for all patients. Moreover, it will indicate the method most likely to succeed in lowering the rectal temperature. Thus, the patient with the hot skin and relatively low rectal-skin temperature gradient has a good blood flow to the skin and

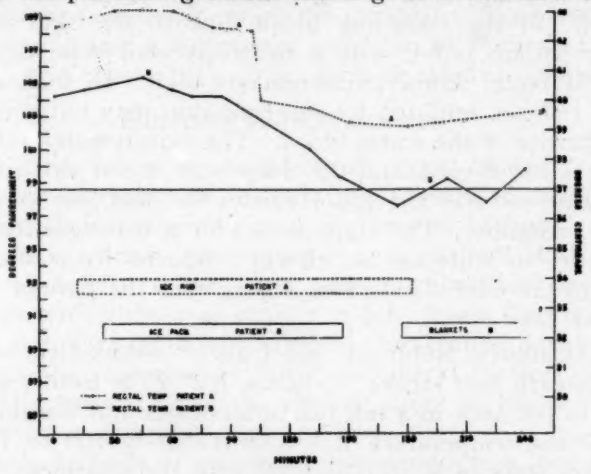

Chart 8. — Delay in fall of rectal temperature during active cooling of the skin in 2 patients with noninfectious fevers.

at least presents a good prospect for the lowering of the deep tissue temperature through the application of cooling agents to the skin. His cutaneous blood vessels are well dilated, and it may be hoped that they will remain so when cold is applied. The patient with the cool skin and the high rectal-skin temperature gradient has a poor blood flow to the skin, and there is less prospect of reducing his deep tissue temperature by application of cold to the skin. His cutaneous vessels are already constricted, and further cooling of the skin may serve only to constrict them further.

The present observations indicate that even when the skin is hot and cutaneous vasodilatation present, cold agents applied to the skin are still likely to produce vasoconstriction and decrease the cutaneous blood flow to the point where little heat is extracted directly from the blood by the cooling agent. Otherwise, it would be difficult to explain the fall in peripheral tissue temperature with little or no fall in rectal temperature. Attempts to maintain the cutaneous blood flow during the period of active cooling by friction of the skin were only partially successful in promoting a rapid lowering of rectal temperature during the cooling. A lag in the fall of deep tissue temperature still persisted, and the maximum cooling effect was not obtained until after the cooling agent was removed. It is of interest in this respect that cooling by conduction through tissue is so poor that rectal temperature was hardly affected by this means. This is not altogether surprising, since the specific thermal conductivity of tissue ($K = 0.0004$ cal./sq. cm./sec./°C.) compares favorably with good insulators and is of the order of wood.[8]

8. Sheard, C.: Temperature of Skin and Thermal Regulation of the Body, in Glaser, O.: Medical Physics, Chicago, The Year Book Publishers, Inc., 1944, p. 1523.

It is still true that cooling of the skin does lower the rectal temperature but often by a delayed response. In the most favorable situations, as the external cold becomes less intense or is removed, blood flow returns to the skin and causes a redistribution of heat between the hot deep tissues and the cold peripheral tissues in favor of a satisfactory fall in rectal temperature. It is of interest, and here physiologically explicable, that the greatest falls in rectal temperature occurred after the phase of active cooling, not during it. The mechanism of this lag suggests that the most effective method of applying external cold may be in short repeated bouts rather than for long sustained periods.

In the unfavorable instances, rectal temperature remains almost unchanged by skin cooling, both during it and afterward. The peripheral tissues are cooled, but the returning blood flow to the skin remains below normal and the patient is left with a relatively cool skin, especially of the extremities. The rectal temperature remains high. In such circumstances, vasoconstrictor reflexes initiated by the cool skin may outweigh the central vasodilating influence of the warm blood. The skin remains relatively bloodless; the blood is not cooled, and the deep heat is not extracted. Furthermore, the cold skin reduces the opportunities for heat loss at the surface by convection and radiation. The stage is set for a maintenance of high deep tissue temperature in spite of the effects produced by cooling. At times the reflexes from the cold skin are so strong that the patient chills and his temperature may even rise.

Ferris, Blankenhorn, Robinson and Cullen[11] reduced the rectal temperature of patients with heat stroke "to below 102° F. in from 9 to 40 minutes" by immersion "to the neck in a tub full of ice water and the skin was rubbed vigorously until the temperature was approximately 100 to 102° F." The experience of the Army in World War II[9] with the treatment of heat stroke also indicated that rapid reductions in rectal temperature could be achieved by similar very vigorous cooling of the skin. The more rapid cooling achieved in these two instances, in contrast to that of the present study, may be the result of their more vigorous external cooling methods. In neither of these instances were thermal gradients reported, and further studies along these lines are desirable during such vigorous external cooling.

The difficulties and disadvantages to deep tissue cooling by the application of cooling agents to the skin raises the question whether cooling from the periphery is the best approach. Other methods for the rapid and effective cooling of the deep tissues require investigation. At least two avenues of approach suggest themselves: (*a*) extraction of heat directly from the deep tissues by the application of cold centrally rather than peripherally and (*b*) the production and maintenance of cutaneous vasodilatation by vasodilating agents (drugs) during the active cooling of the skin.

The rapid reduction of elevated deep tissue temperatures is not solely of academic interest. Rapid, effective and reliable reduction of the core temperature in hyperthermia is imperative for recovery. The experience in World War II[9] indicated that the mortality from hyperthermia is high once the deep tissue temperature exceeds 106 F. Pathologic studies indicated that the essential lesion is damage to brain tissue[10] and that such damage can occur in a very short time, a matter of hours.[9] Although the temperature may subsequently be lowered to and kept at normal, the damage done during the hours of hyperthermia produces irreparable damage from which the

9. Malmud, N.; Haymaker, W., and Custer, R. P.: Heat Stroke. A Clinico-Pathologic Study of 125 Fatal Cases, Mil. Surgeon 99:397 (Nov.) 1946.

10. Lichtenstein, L.: Pathologic Changes Following Therapeutic Hyperthermia: Report of a Case, Am. J. Path. 15:363 (May) 1939. Malmud, Haymaker and Custer.9

patient cannot recover. If such fatal events can occur so rapidly in fit youths, one can guess that similar results may occur even more rapidly, at perhaps lower temperatures, in the less fit, older and ill patients seen in civilian life. In such circumstances it is not enough that the rectal temperature is lowered; it must be lowered rapidly. A lag of several hours in its reduction may prove fatal. A reliable, rapidly effective means of lowering the deep tissue temperature needs to be established.

Finally, there enters into this discussion a plea for more attention to the skin, particularly its temperature and wetness, especially in febrile states. There is a tendency for the physician to measure and consider only the deep tissue (rectal) temperature. A knowledge of the skin temperature and its wetness is essential for an intelligent analysis of thermal balance, or imbalance, of the patient, especially when he is febrile. With such an analysis proper therapeusis against a dangerous fever can be instituted. Without it, the therapeutic agent chosen may do no good or even prove harmful.

Summary and Conclusions

1. Patients with fevers of noninfectious origin tended to fall into two groups on the basis of their skin temperatures: one with a hot, dry, usually nonsweating skin; the other with a cool, dry or moist, skin.

2. During the application of cooling agents, particularly ice, to the skin, prompt falls in superficial tissue (skin and subcutaneous) temperature occurred but usually with little or no change in deep tissue (rectal) temperature.

3. Greater and more rapid falls in rectal temperature commonly occurred immediately after the cessation of active peripheral cooling than during it. A lag between the application of the cooling agent to the skin and a satisfactory fall in rectal temperature thus resulted.

4. Apparently because of cutaneous vasoconstriction, peripheral cooling extracts heat largely or solely from the peripheral tissues and this heat loss is not made available to lower temperature in the deep tissues until a redistribution of heat content between the hot deep tissues and the cold peripheral tissues is brought about by a return of blood flow to the cold skin after cooling is stopped.

5. A reliable method for rapidly and effectively lowering dangerously high deep tissue temperature is essential, since hyperthermia, even for several hours, can cause irreparable damage to central nervous system tissue with subsequent death.

Dr. Roy E. Albert participated in many of the observations, and Mr. William H. Becker, rendered valuable assistance during the entire study.

The discussion of this article will appear in a later issue of the ARCHIVES.

SOME OF THE FORCES EXERTED IN THE NORMAL HUMAN GAIT *

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and

MARGARET GREGSON

LOS ANGELES

The purpose of this paper is to present data now available in connection with our long term study of locomotion in normal and in pathologic conditions. These results comprise some of the basic data to be resolved in the final analysis and have sufficient interest in themselves to warrant their presentation at this time.

A dynamic analysis of the motion of the muscular and skeletal components of the human body was made by means of measurements of the forces and the torque exerted. This involved the use of strain gauges, amplifiers, oscillographs, etc. The data thus obtained were resolved into a mathematical system of forces, and this was solved in terms of external and inertia loads acting upon the member concerned. The mathematical results, in turn, have been interpreted in terms of the orginal muscular and skeletal elements. To date no complete analysis of this type has been made. Otto Fischer[1] determined the inertia forces acting in three dimensions for three subjects but lacked a method of measuring the ground reactions. He used the inertia force data to predict the ground reactions for separate subjects but failed to present a quantitative pattern combining his results. Bernstein[2] similarly failed to devise a method for consolidating his individual test data. Furthermore, he noted the necessity of taking many small intervals of time in order to observe all the fluctuations of his load data but vitiated this result by averaging his accelerations, thus eliminating the sharp fluctuations in his results. Moreover, he neglected the effects of angular accelerations. Like Fischer, he used his data to predict ground reactions because he did not have a "force plate" (ground force-measuring device). A procedure involving the use of the oscillographic method had been used by Schwartz and Heath.[3] Elftman[4] devised a "force plate" but worked out his final inertia data in two dimensions, neglecting lateral loads and moments, and moreover his "force plate" did not measure torsional forces. These neglected forces are significant, particularly since most pathologic deviations result in abnormal

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* Read at the Twenty-Fifth Annual Session of the American Congress of Physical Medicine, Minneapolis, Sept. 4, 1947.

1. Fischer, O.: Theoretische Grundlagen für eine Mechanik der lebenden Kőrper, Leipzig, B. G. Teubner, 1906.

2. Bernstein, N. A.: Biodynamics of Walking of Normal Adult Man, Moscow, Institut f. experimentelle Medizin d. Soviet Union (Wiem), 1935.

3. Schwartz, R. P., and Heath, A. L.: The Definition of Human Locomotion on the Basis of Measurement, J. Bone & Joint Surg. 29:203, 1947.

4. Elftman, H.: A Cinematic Study of the Distribution of Pressure in the Human Foot, Anat. Rec. 59:481, 1934. Elftman, H., and Manter, J. T.: The Axis of the Human Foot, Science 80:484, 1934. Elftman, H.: The Force Exerted by the Ground in Walking, Arbeitsphysiol. 10:486, 1939; Forces and Energy Changes in the Leg During Walking, Am. J. Physiol. 125:339, 1939; The Function of Muscles in Locomotion, ibid. 125:357, 1939; The Rotation of the Body in Walking, Arbeitsphysiol. 10:177, 1939; Experimental Studies on the Dynamics of Human Walking, Tr. New York Acad. Sc. 6:1, 1943; The Orientation of the Joints in the Lower Extremity, Bull. Hosp. Joint Dis. 6:139, 1915.

lateral motion. Therefore it is important to determine the normal pattern of these forces. Finally, it is vital to present a quantitative normal gait pattern based on the combination of a sufficient number of cases as to give statistically satisfactory results. These results must also be in such form that quantitative comparisons are possible for study of deviations.

To introduce the following material, it is advisable to recall the precise definitions of velocity and acceleration; the rate of change of distance with time is called velocity, and the rate of change of velocity with time is called acceleration. In order to make quantitative analyses, equipment was developed for measuring the forces acting on the leg during locomotion (chart 1).

There are present during locomotion the inertia forces produced by the resistance of the moving members to the acceleration of gravity and to the accelerations required to move the body in its action (chart 2). There is also present the external reaction to these loads as the foot contacts the ground.

The force plate measures the reactions of the foot at the ground contact point and provides a continuous measurement of the horizontal, vertical and lateral reactions in pounds and also of the lateral torque or moment present at the contact point as seen on the oscillographic tape (chart 3). The plate also locates the reaction point as the weight shifts forward from heel to toe and from side to side. The resolution of the graphs shows that these forces have a normal predictable pattern, with the result that the deviations from this pattern may be used to detect abnormality of gait.

However, it is not sufficient for purposes of diagnosis to know that the ground reaction pattern is abnormal. It is desirable to find the exact location of the cause of the deviation; hence it is necessary to establish the normal manner in which these loads are transmitted to the various portions of the lower extremity. For this purpose it is necessary to establish the interval in inertia loads producing the reaction and study the inertia forces acting on each of the members.

The accelerations due to motion are recorded by the grid arrangement of the high speed x-ray motion pictures,[5] and these are synchronized with the force plate so that the position of the joints at the successive stages of the motion may be correlated with the force plate loads. As the leg moves forward, its speed varies at different stages, and thus there is present in each separate member a horizontal acceleration, as well as some vertical and some lateral acceleration. These are accelerations due solely to change in position and are in addition to the acceleration of gravity which acts toward the ground. These accelerations are resisted by the weight of the member and produce inertia forces which are measured quantitatively by Newton's first law — "force equals mass times acceleration." Similarly, as the parts of the leg move, they tend to rotate, causing angular velocities and resultant accelerations. These are also determined quantitatively from the location of the parts and produce inertia moments equal quantitatively to the product of the mass moment of inertia of the part by its angular acceleration.

The normal pattern must be established by combining data from many persons of varying weights and taking various amounts of time to perform the required motion. Therefore the individual analysis must be reduced to comparable units. Knowing all of the forces which are acting on the various parts of the leg, it is possible to determine the exact loads in pounds and moments in inch pounds at any point of the entire leg at each stage of the motion of each subject. The data are analyzed separately, since the acceler-

5. Rehman, I.: High Speed X-Ray Motion Picture Studies, J. Biol. Photographic A. 16:15, 1947; A Study of the Kinematics and Dynamics of the Human Gait and Its Application in Poliomyelitis, Arch. Phys. Med. 28:749, 1947.

ations are dependent on the actual amount of time between phases. All loads are converted to percentages of weight and all data reduced to similar inter-

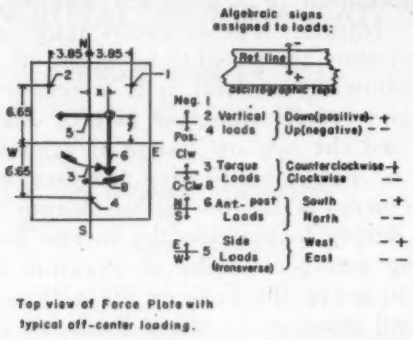

Chart 1. — Diagram of force plate to show the directions of the forces and the algebraic signs assigned to the various loads and torques as recorded on the oscillograph tape.

vals of time (40 per second) — that is, at certain percentages of the total interval of motion. This is the final development of the normal pattern to which deviations are compared.

The data obtained as "force plate" curves made it possible to trace the "normal pattern" of all reaction loads at the ground contact point. Deviations

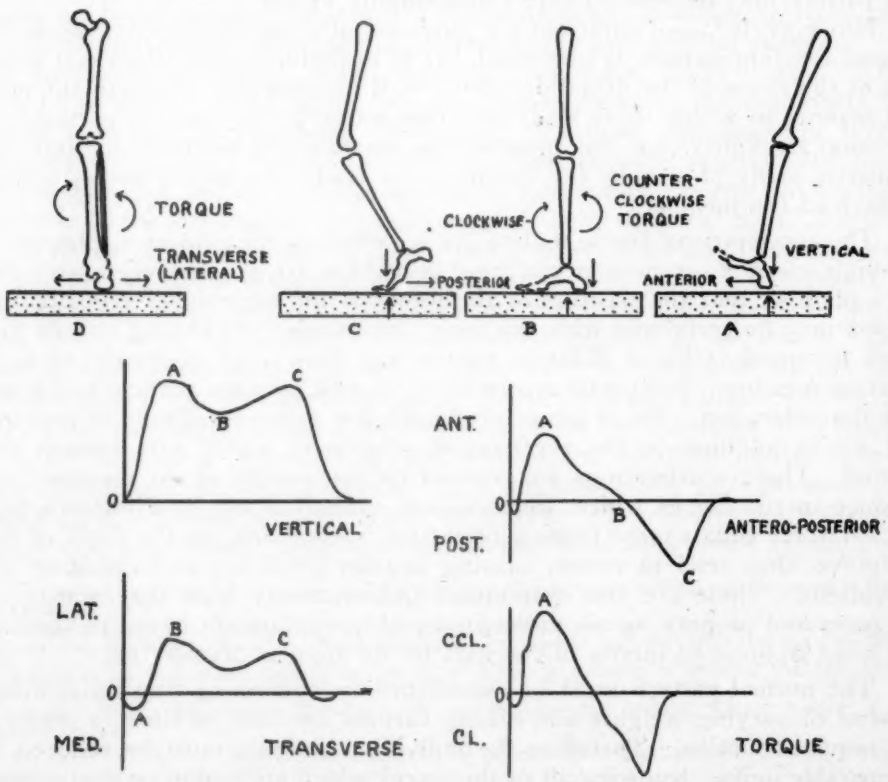

Chart 2. — Points of application (*A, B, C*) and directions of forces exerted indicated in relation to some of the various phases of motion of the lower extremity during a normal stride. The position of the extremity in its stride is indicated on the graphs by *A, B, C.*

from this established normal may be used to detect abnormalities. The following types of data were recorded for each phase of ground contact and each follows a definite predictable form:

A. Vertical Load. — This consists of two peaks which occur at approximately 22.5 and 72.5 per cent of the full stride. These peaks correspond to the lifting of the nonrecording foot, transferring full weight to the foot on the ground, and to pushing down preparatory to lifting the foot from the ground. The force exerted consists of the body weight plus the force that is necessary to elevate it to the other foot and is therefore

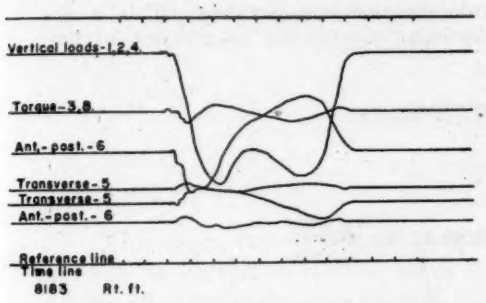

Chart 3. — Typical multiple trace oscillographic record of various forces exerted during normal gait. Trace numbers refer to force plate recordings (chart 1); time is expresed in 0.1 second intervals.

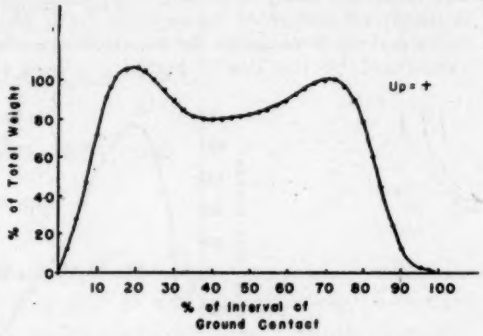

Chart 4. — Vertical load. The stride has been broken down into terms of 100 per cent for the full stride. Peak loading occurs at approximately 22.5 and 72.5 per cent.

greater than the total body weight. The minimum is the weight of the body minus the pull of gravity tending to lower it. The vertical load increases with the increase in the speed of walking (chart 4).

B. Horizontal Load (anteroposterior). — The horizontal reaction is the most consistent of the three loads. During the first half of the period, the reaction is directed posteriorly as the foot pushes forward from the momentum gained in the swing and is stopped by

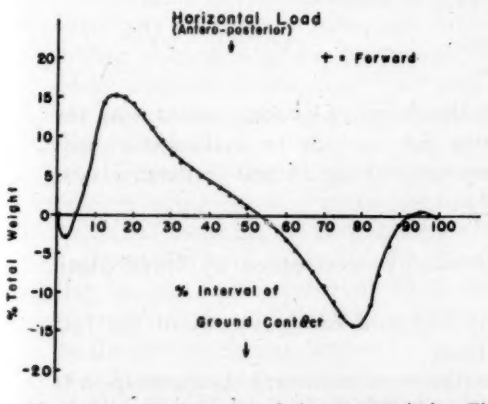

Chart 5. — Horizontal load (anteroposterior). The total stride represents 100 per cent. Peak loading occurs at both phases of foot contact and corresponds in time with the vertical peak loads.

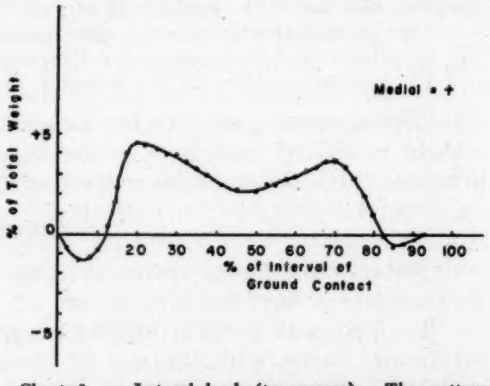

Chart 6. — Lateral load (transverse). The pattern represents the tendency of the antagonistic muscle groups to stabilize the lateral motion of the center of gravity of the body. The peak loading also corresponds with that in the vertical and the horizontal direction.

ground contact. In the second half, the reaction is forward, as the foot pushes back preparatory to leaving the ground. The peaks of this load correspond to the peaks in the vertical load (chart 5).

C. Lateral Load (transverse). — The lateral load pattern shows more individual characteristics than the others. In general, the reaction is medial, representing a force which stabilizes the lateral motion of the body center of gravity. In some persons it ends with an outward reaction, due to overswing of the body, whereas in others it remains medial throughout (chart 6).

The resultant of these three loads is a reaction equal and opposite to the force exerted by the foot on the ground.

D. Torque. — The torque indicates one peak (approximately 92 inch pounds) at approximately 25 per cent of the interval, the direction of twist being counterclockwise, and a second peak at approximately 75 per cent of the interval, directed clockwise.

These rotations react to the lateral and forward reactions of the body center of gravity (chart 7).

To illustrate the torque sequence: As the heel of the right foot makes contact with the ground, the left foot will push off, causing the body to rotate in the direction of the right foot, i. e., clockwise. Then as the left foot swings forward, the right foot will rotate the body laterally, resulting in an internal rotation of the body. This rotation is produced and must be resisted by a positive torque. This positive torque must be restrained by a negative or countertorque in order to prevent overriding. This is accomplished by the lateral rotators. This produces an alternating progression of im-

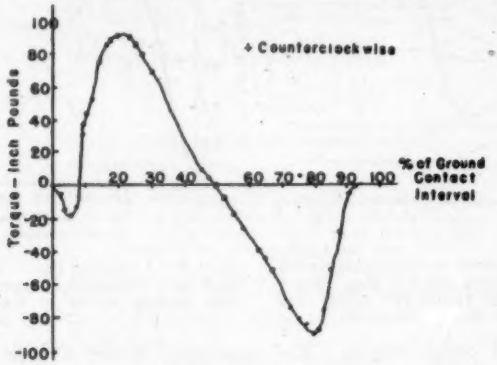

Chart 7. — Torque at ground contact point plotted for a typical subject. The action of antagonistic muscle groups can be seen in direction of the torques as the center of gravity of the body is maintained in a forward motion.

balance and balance in the torque or rotational forces (caused by the hip and thigh muscles) and assists in moderately straight forward locomotion.

Two other measurements are also made:

E. Horizontal Location of the Reaction Point.

F. Lateral Location of the Reaction Point.

These coordinates give the location of the point of ground contact as the weight is shifted from heel to toe and from side to side to maintain equilibrium as the body moves over the foot. They are not significant in themselves.

Summary

Some of the forces involved in locomotion as determined by force plate measurements have been resolved.

1. The peak vertical loading occurs at 22.5 and 72.5 per cent of the full stride and varies with the rate of locomotion.

2. The peak loading in the anteroposterior measurements corresponds with that of the vertical loading. The first peak load represents a posteriorly directed ground reaction to the forward motion of the foot. The second peak is a forward ground reaction to the posteriorly directed force of the foot.

3. The transverse load is balancing action on the part of the musculature to maintain a constant axis through the center of gravity of the body when only one foot contacts the ground. The recording of these transverse forces show individual variance; hence no generalized conclusion could be reached.

4. The torque loads correspond in time intervals in their peak loading to the vertical and anteroposterior loads. They provide the lateral or rotatory forces necessary to maintain the forward motion of the body in a straight line.

STUDIES IN LOW BACKACHE WITH PERSISTENT MUSCLE SPASM *

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and
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ST. LOUIS

The study reported here, a combined study of the patterns of muscular activity in acute and chronic back disorders and of the effectiveness of certain modes of treatment, was carried out as an attempt to obtain some objective evidence on this condition in terms of the action of muscles.

It is common experience that pain induces alterations of normal posture and of patterns of activity in an attempt to avoid further pain. The patient with a painful back usually shows asymmetrical patterns of muscular activity. In chronic cases, relief of the pain may not restore normal activity; in the presence of these chronic back ailments there is probably a persistence of abnormal activity that developed as an attempt to avoid or relieve pain and became habitual during the acute stage.

Since a person rarely uses only one muscle or part of a muscle to perform any activity or maintain any posture, the pattern of a group of muscles acting during a given movement is of more significance than the response of an individual muscle. Any one muscle acting in an abnormal pattern of movement may give an electromyographic record of quite normal physiologic contraction.

In attempting to study and evaluate the reactions to pain, these several related procedures present themselves. 1, localization of painful regions by repeated mapping of palpable painful foci; 2, analysis of movement as a guide to the abnormal patterns of activity using electromyographic recording during simple routine test postures and movements; 3, removal of pain, either by treatment of the acute pain or by correction of abnormal patterns of activity in the chronic stage.

It seemed desirable to start with a simple type of disorder, muscular strain and the resulting abnormal patterns or postures. Therefore, in selecting patients for study, we have eliminated those with fractures, dislocations, pathologic bone and visceral conditions and spondylolisthesis. Patients exhibiting hyperactivity of the muscles due to joint irritation, arthritis or psychogenic disturbances have been studied, but the selected ones have been those with simple muscular strain from trauma or postural defects. Cases in the acute stage have been followed through to complete recovery whenever possible.

Material and Methods

Localization of Pain Spots. — Patients are given a complete clinical examination, including roentgenograms if indicated. Then a chart is made of areas painful or tender on palpation (chart 1). A chart is made of these areas each time the patient returns for treatment. Three types of discomfort are noted in detail: (1) acute pain on palpation; (2) tenderness on palpation and (3) discomfort reported by the patient during

* This work was aided by a grant from the Baruch Committee on Physical Medicine.
* From the Departments of Physical Medicine, Barnes Hospital and Washington University.
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movement or at rest but which cannot be localized by palpation. The constancy or mobility of these pain areas is followed as related to the pattern of muscular activity.

Electromyographic Studies. — Electromyograms of the back musculature are recorded by means of five stage Grass amplifiers connected with a three channel ink-writing oscillograph. The recording electrodes are, in most cases, surface leads made of a wet mixture of modeling clay and plaster of paris. These leads were chosen because the average activity of a large part of a muscle or a muscle group is more significant

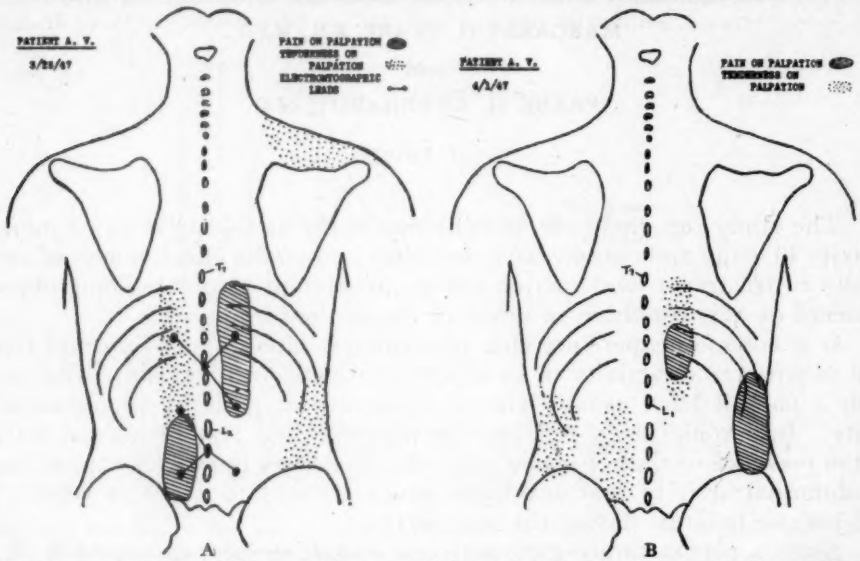


Chart 1. — *A*, areas painful or tender on palpation and leads for electromyographic recording. B, painful and tender areas of the same patient seven days later.

in the study of movement than is the function of some random single motor unit. In the earlier experiments, needle electrodes were used; but as the presence of the needle in a painful muscle area produced prolonged pain, it was felt that this did not give an accurate picture of the state of the muscles.

The electrodes are placed on the skin over corresponding areas of the erector spinae muscle bilaterally and lead to a common electrode on or between the spinous processes of the vertebrae (chart 1 *A*). The spinal level at which the recording is made is determined by the location of painful areas in each individual case.

The routine muscle records involve movements which have been selected so as to require varying amounts of activity in the different portions of the erector spinae muscle. The movements are explained to the subject, and he is allowed to determine the exact amount of movement himself, since the aim is a record of the spontaneaus pattern of activity and relative amounts of activity of various areas of the paraspinal muscles. It is obvious that under these conditions the type as well as the amount of activity performed by the patient with a painful back, by comparison with records from normal subjects, will be indicative of the actual state of the back. One critical feature looked for is asymmetrical records from movements normally involving symmetrical action.

Treatment. — The patient's condition is classified as acute or chronic, and the treatment prescribed accordingly. In acute cases, heat, either diathermy or infra-red radiation, is used to assist relaxation and improve circulation. Various other measures are added: massage, which involves no effort on the part of the patient; relaxation, which requires conscious effort by the patient but no movement; electrical stimulation of the muscles, which might be considered a type of passive exercise, and mild exercise involving the muscles as synergists or antagonists.

In some cases with more superficial pain, infra-red radiation has been used; if the patient suffers from deep-seated pain or exhibits severe pain reactions of any kind, diathermy has been applied because of its greater penetration.[1] In cases of severe pain, massage or relaxation is used rather than electrical stimulation of the muscles or exercise.

The patients with chronic conditions will presumably have developed habitual embarrassment of movement requiring correction. In cases in which muscle reeducation is attempted, three methods are used: (1) posture training and light exercise; (2) relaxation technics, and (3) rhythmic movements.

1. Kovács, Richard: Electrotherapy and Light Therapy, Philadelphia, Lee & Febiger, 1945, p. 213.

The method used to obtain relaxation aims toward training the subject to relax symmetrically, leaving the spine in good physiologic alinement. The patient lies supine on a hard bed, a small pillow under the head and arms crossed loosely on the chest. The hips and knees are flexed to reduce the lordosis, which otherwise is increased when lying supine, owing to relaxation of the abdominal muscles and a tendency of the hip flexors to rotate the pelvis downward. A period of five or ten minutes is devoted to concentration by the patient on mental images which suggest "softening" in various parts of the body. The patient is then alined by the therapist, and complete relaxation of the erector spinae is attempted. After relaxation is attained, the patient is taught to get up with as little strain to the back as possible and to maintain good posture while walking. Often relaxation achieved in various parts of the body during this period may thus be maintained for a considerable period afterward. The end in view, as in all postural training, is to establish a habit of maintaining good body alinement during activity as well as rest.

Another series of patients with chronic conditions with definite postural defects and discomfort (but no acute pain) have been placed on a reeducation program of training for correct posture.[2] By means of carefully selected exercises, many of these patients are made conscious of the correct postural pattern; these exercises are designated to relax and lengthen the habitually shortened muscles and to increase the tone of the stretched muscles.

The rhythmic movements mentioned here have been selected by Dr. Ewerhardt to assist in reeducating the back muscles in coordinated movement,[3] aiding relaxation of tense muscles and improving the circulation. They are given, not as an exercise, but rather as a means of obtaining alternate mild contraction and relaxation of the erector spinae and other back muscles by lateral bending plus rotation of the trunk. Since forward flexion of the trunk in the majority of these cases increased the pain and tension in the erector spinae, this movement is avoided as much as possible; the rhythmic movement, which produces no pain, is substituted.

Results

Localization of Pain Spots. — The painful foci often shift from one erector spinae to the opposite side or from one portion to another on the same side. Chart 1*B* represents the same patient shown in chart 1*A* seven days later, with the shift of pain.

Electromyographic Studies. — Normal untrained subjects show remarkable consistency in following specific patterns of activity in the test movements. There is complete relaxation at rest. In turning the head from one side to the other, the upper leads show weak action. In head raising, the activity of the upper leads is moderate while that of the lower back is weak. Increased hyperextension of the spine to raise the head and shoulders requires strong contraction of the erector spinae bilaterally. There is strong activity on the side toward which the trunk is flexed and moderate or weak activity on the opposite side during lateral flexion. When one hip is hyperextended, the contralateral thoracic erectores spinae respond with moderate activity in a stabilizing action.

On the basis of this normal pattern, certain criteria can be set up for judging records of patients with back disabilities. The marked deviations from the normal pattern are these: (1) asymmetry of action in movements

2. Ewerhardt, F. H.: Posture, in Medical Physics (Otto Glasser, editor), Chicago, The Year Book Publishers, Inc., 1944, pp. 1114-1117.
3. Ewerhardt, F. H.: Rhythmic Movements in Chronic Backache, Arch. Phys. Therapy, 22:404 (July) 1941.

where bilateral symmetry is expected; (2) overaction of a region; (3) underaction by comparison with normal subjects in the same situation.

Hyperactivity of a muscle or group of muscles may be due to reflex stimulation from pain, of the character of spasm, or it may be due to attempts to avoid contraction of a muscle whose activity produces pain. As would therefore be expected, there are cases in which the excess of activity is recorded on the same side as the painful region and other cases in which the hyperactivity is opposite the pain.

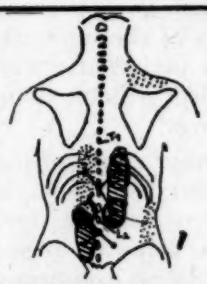
Analyses of the electromyograms of 2 patients are presented in chart 2. In

A

PATIENT A. V. 3/25/47

MOVEMENTS		LEFT			RIGHT		
		UPPER	MIDDLE	LOWER	UPPER	MIDDLE	LOWER
RESTING	BEFORE TEST	0	+	0	±	+	0
	AT END OF TEST	0	+	0	+	±	0
TURNING HEAD	TO RIGHT	+++	+	+	+++	++	++
	TO LEFT	+++	+	+	++	++	++
RAISING HEAD *		+++	+	++	+++	+++	+++
RAISING HEAD & SHOULDERS		++++	+	++	++++	+++	++++
LATERAL FLEXION OF SPINE	TO RIGHT *	++++	+	+++	+++	+	++++
	TO LEFT	++++	+	++	+++	++	+++
HYPEREXTENSION OF HIPS	RIGHT	0	±	0	0	0	±
	LEFT *	+	±	++	++	+	++

* INDICATES PAIN DURING MOTION



ELECTRODES FOR EMG
PAIN ON PALPATION
TENDERNESS ON PALPATION

ACTIVITY GRADED FROM:
NO ACTIVITY RECORDABLE 0,
OR MINIMAL ACTIVITY ±,
TO STRONG ACTIVITY ++++.

RIGHT MIDDLE LEAD HYPOACTIVE DURING PAIN; LEFT MIDDLE LEAD HYPOACTIVE THROUGHOUT TEST.

B

PATIENT A. M. 4/19/47

MOVEMENTS		LEFT			RIGHT		
		UPPER	MIDDLE	LOWER	UPPER	MIDDLE	LOWER
RESTING	BEFORE TEST	+	+	0	0	0	+
	AT END OF TEST	+	±	0	+	+	0
TURNING HEAD	TO RIGHT	++	+++	++	++	++	++
	TO LEFT	++	++	++	++	++	++
RAISING HEAD *		++++	++++	+++	++++	++++	+++
RAISING HEAD & SHOULDERS		++++	++++	+++	+++	++	+++
LATERAL FLEXION OF SPINE	TO RIGHT	+++	+++	+++	++++	++	+++
	TO LEFT	++++	+++	+++	+++	++	+++
HYPEREXTENSION OF HIPS	RIGHT *	+++	+++	++++	++	+++	++++
	LEFT	++	+++	++	++	+++	+++

* INDICATES PAIN DURING MOTION

ELECTRODES FOR EMG
PAIN ON PALPATION

ACTIVITY GRADED FROM:
NO ACTIVITY RECORDABLE 0,
OR MINIMAL ACTIVITY ±,
TO STRONG ACTIVITY ++++.

PAINFUL AREA AVOIDS STRONG ACTION UNTIL PAIN OCCURS, THEN SHOWS SPASM.

Chart 2. — *A*, analysis of the electromyographic record of patient A. V. Right middle lead is hypoactive during pain; left middle lead is hypoactive throughout test. *B*, analysis of the electrographic record of patient A. M. Painful area avoids strong action until pain occurs, when it shows spasm

patient A. V. (chart 2*A*), there is weak activity at rest (before the test and also at the end of it) on the left middle, right upper and right middle leads. The left middle lead shows consistent weak activity during rest and all test movements. On lateral flexion of the trunk toward the right (which causes pain), the left upper lead comes in strongly and the right middle lead shows less activity than would normally be expected. The right middle lead also

shows weak activity during hyperextension of the left hip (with pain in the left lumbar region) instead of the usual moderate activity under normal conditions. Hyperextension of the right hip is performed almost without involvement of the erector spinae masses bilaterally. There is minimal activity on the left middle and right lower leads. There is no pain. There is "resting activity" on three leads from painful areas (left middle, right upper and right middle). The left middle lead is hypoactive on all movements. The left upper lead (a tender area without acute pain) is hyperactive when there is pain on the opposite side. The right middle lead (on a painful area) is hypoactive when there is pain in that region and also when the pain is in the opposite side.

In patient A. M. (chart 2*B*) the right middle lead is over an area painful on palpation. There is less activity on hyperextension of the spine (raising head and shoulders) and on lateral flexion of the spine to the right than would be expected in a normal person. Although there is no pain during these test movements, it may be inferred that the reduced activity is due either to mild discomfort or threatening pain or to a habitual shift of activity to avoid pain. In hyperextension of the right hip (a movement which causes increased pain), the right middle lead shows moderate activity and the right lower lead strong activity, whereas in normal subjects this movement produces little activity on the right side. This area which is painful on palpation shows hypoactivity on motion until pain occurs, at which time it shows hyperactivity.

Treatment

Too few cases of back pain have been studied in detail to allow any attempt at evaluation of the various types of treatment. It should be noted that some patients recover after only two or three treatments, whereas others show no improvement after a number of treatments. The one point which seems to stand out is this: Those patents who have been able, by any treatment used, to secure good relaxation of the tense muscles during rest and to avoid abnormal activity patterns during movement have shown marked improvement, often complete recovery. Those whose muscles remain hyperactive during movement show no appreciable improvement — that is, pain or discomfort continues as long as abnormal patterns of movement persist. In other words, two points become obvious: (1) The immediate cause of the patient's embarrassment, whatever the original pathologic change or injury, often involves abnormal patterns of muscle tension. (2) In many cases the ability to correct abnormal patterns of movement indicates that this disturbance is not merely a symptom of some underlying defect but is a chronic or habitual abnormality of function. Even when an organic defect exists which, with failure under unusual strain, occasions an acute episode, the abnormal pattern of activity induced may either maintain the condition of strain instead of relieving it or set up postural strains equally disturbing. The solution of the difficulty then seems often to lie in combining the alleviation of the original damage with correction of its more or less chronic sequelae.

Some of the patients with chronic discomfort have no history of trauma or known cause for the onset of muscle pain. Arthritic patients with long-standing poor postural and activity patterns fall into this group. Such patients have backs easily subject to strain from simple acts and thus have repeated flare-ups which result in acute muscular strain. Patients with postural defects from any other cause also fall into this group and are liable to muscle strains when performing rapid or even simple movements involving the back musculature.

The treatment designated for a given patient is thus partly determined by the character of the ailment, and the ideal experimental procedure of applying different types of treatment to an unselected run of subjects is not feasible. This renders it difficult to evaluate the relative effects of the different treatments until a large series of cases has been handled.

Comment

Pain, or the threat of pain, may cause one to establish abnormal patterns of activity and consequent faulty posture. Subthreshold pain, as discomfort, may be sufficient to induce the establishment of unnatural patterns which throw the motor system out of balance. If one region is painful, the contralateral muscles may be kept under constant tension (spasm) to prevent a painful contraction of the muscles at the site of the original lesion. This constant abnormal tension necessitated by a persisting threat of pain may establish secondary sources of discomfort: faulty posture and resulting liability to strain, or prolonged contraction of a muscle, reducing the blood flow into that muscle. Exercising an ischemic muscle will produce pain, without other pathologic changes. This appears to be an important factor in the shift from time to time of the areas which are painful. It would also explain why relief is obtained by those patients who are able to secure relaxation of the tense muscles, by means of the conscious relaxation technic, through use of the rhythmic movements or by any other medium.

Electromyograms give an objective analysis and detailed account of the way in which the patient is using the back muscles under stress. Their use is warranted in further analysis of back disorders and possibly as part of the routine clinical examination in certain cases of back pain.

In such records, overaction as compared with the normal may indicate an avoidance of painful contraction in one muscle by substituting a less appropriate or less effective one, or it may indicate refusal to extend a potentially painful muscle when stretch would increase discomfort. That is, passive or active sparing of painful stimulation may occur. Underaction may result from reflex inhibition from pain or even threat of pain or discomfort. The whole pattern must be examined to determine the significance of a given feature of the pattern. The resulting abnormal posture or movement may set up new sources of strain and discomfort and lead to habitual faulty posture as the lesser evil. Abnormal tensions thus reactivated in succession may account for the wandering of areas painful to palpation, leading to confusion as to where the site of an original lesion actually is. In these circumstances correction of postural and movement patterns may constitute as significant a phase of treatment as removal of an original source of difficulty or may uncover the essential difficulty itself.

Summary

Patients with acute and with chronic back pain (resulting from simple muscular strain, joint irritation, arthritis or psychogenic disturbances) have been studied through three methods: (1) localization of painful regions by repeated mappings of palpable painful foci; (2) removal of pain, either by treatment of the acute pain or by correction of abnormal patterns af activity in the chronic stage; (3) analysis of movement as a guide to the previous methods, using electromyographic recording of simple routine test positions and movements.

It has been found that the areas of pain or tenderness migrate from one muscle group to another or from one part of a muscle group to another region of the same group. This shift of pain seems to be associated with the

abnormal patterns of muscular activity developed in an attempt to avoid or relieve pain.

Electromyographic studies during test movements have given objective evidence of such patterns of activity and of the relative amounts of activity in various muscle groups in relation to pain as compared to normal subjects. Relief of the abnormal tensions in the muscles by correction of the abnormal patterns of activity may assist greatly in alleviating discomfort and preventing recurrences of pain.

CONSERVATIVE TREATMENT OF SCOLIOSIS IN SELECTED CASES

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Scoliosis without structural bone changes should theoretically yield to correction when a balance is reestablished between the structures of the back and the demands that are made on them. It is our opinion that use of the brace which we are describing, together with intelligent use of therapeutic exercises, will bring correction in certain cases and definite limitation of progression in others.

Definition

Scoliosis is a rotary lateral curvature of the spine. A series of vertebral spinous processes show a constant deviation from the median line of the body. The deviation is always accompanied with some degree of twisting. Curves are termed right or left according to their convexities and are further described according to the anatomic region of the spine involved. Shands[1] stated that "scoliosis is a deformity rather than a disease and is often secondary to pathologic changes outside of the spine itself."

Mechanism

Scoliosis is the result of poor body mechanics, which, in turn, is the result of some defect, disease or, more frequently, some unknown or undiscovered factor.

Body mechanics has been described thus by the White House Conference on Child Health and Protection: "Body mechanics is the mechanical correlation of the various systems of the body with special reference to the skeletal, muscular, visceral and neurological systems." Body mechanics is not a rigid and readily recordable status, inasmuch as it varies with different types of persons. Slender, heavy and intermediate types and variations with-

1. Shands, A. R., Jr., and Raney, R. B.: Handbook of Orthopedic Surgery, ed. 2, St. Louis, C. V. Mosby Company, 1940.

in these categories are recognized. When average or normal relationships exist, particularly among the skeletal, muscular, visceral and neurologic systems, there is good body mechanics.

Brown[2] stated that "good body mechanics implies that all the joints of the body are used in such a position in relation to their total range of motion that there is always more motion in either direction, the so-called factor of safety motion." Scoliosis usually occurs early in life. Patients have little or no trouble with curves of moderate severity, and the discovery of the condition is delayed until it is noticed by a parent, teacher or playmate or on the occasion of a routine physical examination. The curve, however, may increase and cause structural changes, pain and asymmetry which bring the patient to a physician.

Lateral curvature is best regarded as a progressive condition which, according to Jones and Lovett,[3] passes over only one sharp line, the transition from structural curves to functional or organic ones. Lovett[4] further stated that bony rotation or twisting of the vertebral bodies always accompanies organic lateral curvature in which structural changes have occurred in the vertebrae. This is due to the fact that the vertebral column is a flexible weight-bearing rod curved in the anteroposterior plane. A plastic weight-bearing column already curved in one plane cannot yield in another without twisting, and in this twist the vertebra can turn in only one way — away from the greatest weight and pressure, which is, of course, on the concave side of the lateral curve — hence they must turn to the convex side. The plastic bones yield to unequal strains, and the deformity becomes perpetuated by secondary changes. Ober and Brewster[5] separated scoliosis into two types which is most applicable when considering treatment. These two types are functional, or false, scoliosis and structural, organic or true, scoliosis. The term functional scoliosis is applied to cases in which the spine forms one gradual curve to one side without compensatory curves. Ober and Brewster[5] stated that in 90 per cent of such cases the curve is to the left. The typical characteristics of left scoliosis are as follows: (1) There is a general curve convex to the left; (2) the left shoulder is elevated; (3) the right side of the shoulder girdle is carried back and the left side forward; (4) when the patient bends forward, the right side of the back may be slightly higher than the left. Functional curves disappear on suspension or recumbency, and side flexibility is but little limited. This type of curve may be produced by placing a book under the right foot, raising the right side of the pelvis and necessitating for balance a left convex curve of the spine. This condition is obviously associated with a poor spinal attitude.

There is a transitory stage between the functional and the organic type which can be explained physiologically as a compensatory mechanism.

When the beginning curves attempt to pass beyond a certain stage, the instinctive tendency toward equilibrium and balance of the normal spine probably comes into play. This mechanism attempts to square the shoulder girdle with the pelvis and to keep the head and upper part of the spine as nearly as possible in the median line of the body. Individual vertebral columns vary in many respects, and this compensatory adjustment will take various forms.

Structural curves are just what the name implies. Structural changes are present in the vertebrae, and any of the varieties of structural scoliosis present themselves.

2. Brown, L. T.: In Principles and Practice of Physical Therapy, edited by H. E. Mock, R. Pemberton, and J. S. Coulter, Hagerstown, Md., W. F. Prior Company, Inc., 1932, vol. 1, chap 3.
3. Jones, R., and Lovett, R. W.: Orthopedic Surgery, New York, William Wood & Company, 1923.
4. Lovett, R. W.: Boston M. & S. J. 142:622, 1900.
5. Lovett, R. W.: Lateral Curvature of the Spine and Round Shoulders, ed. 5, edited by F. R. Ober, and A. H. Brewster, Philadelphia, P. Blakiston's Son & Co., 1931.

Ferguson and Risser[6] have shown from growth studies that the increase in curvature stops only upon the cessation of vertebral growth. It has been determined that ultimate growth in vertebral height is attained by girls at or before the age of 16, the average age being 14; by boys at or before 17, the average being 16.

Etiology

Ober and Brewster[5] have listed the causes of scoliosis as follows:

A. Congenital scoliosis
   1. Malformation of the structures of the spine
   2. Malformation of the scapula
   3. Malformation of the thorax
   4. Deforming intrauterine pressure
   5. Paralysis of intrauterine origin

B. Acquired scoliosis
   1. Anatomic, physiologic or other asymmetries elsewhere than in the spine
      (*a*) Torticollis (wryneck)
      (*b*) Pelvic asymmetry
      (*c*) Pelvic obliquity (short leg)
      (*d*) Unequal vision
      (*e*) Unequal hearing
   2. Pathologic affections of the vertebrae
      (*a*) Rickets
      (*b*) Osteomalacia
      (*c*) Pott's disease
      (*d*) Syphilis
      (*e*) Dislocation
      (*f*) Arthritis deformans
      (*g*) Tumors, etc.
   3. Pathologic affections of the bones and joints of the extremities, causing asymmetrical position
      (*a*) Diseases of bones and joints of the legs
      (*b*) Diseases of bones and joints of the arms
   4. Distorting conditions due to disease of the soft parts
      (*a*) Infantile paralysis
      (*b*) Spastic paralysis
      (*c*) Nervous diseases (hemiplegia, syringomyelia, etc.)
      (*d*) Empyema
      (*e*) Organic heart disease
      (*f*) Scars
      (*g*) Throat, abdominal or pulmonary disease
      (*h*) Acute or chronic inflammation of the spinal muscles (lumbago, etc.)
   5. Habit or occupation

Von Lackum[7] has expressed the opinion that of the patients presenting themselves for treatment of structural scoliosis approximately 20 per cent can give an adequate cause for the deformity and in 80 per cent no cause can be determined. For some reason, the spine does not withstand the strains required of it. These cases in which the cause is undetermined or unexplained are frequently termed instances of idiopathic scoliosis.

Diagnosis

Each case of scoliosis merits complete individual study with all methods available to the physician. All the possibilities mentioned by Ober and Brewster must be carefully considered. If a lateral curvature of the spine exists, scoliosis is present and in any degree merits therapy.

It is most important to differentiate between a functional curve, or false scoliosis, and an organic curve with structural changes. Conservative therapy is indicated when the functional curve without structural bony changes

6. Ferguson, A. B., and Risser, J. C.: J. Bone & Joint Surg. 18:667, 1936.
7. Von Lackum, W. H.: Surgical Treatment of Scoliosis, in Surgical Treatment of the Motor-Skeletal System, edited by F. W. Bancroft, and C. R. Murray, Philadelphia, J. B. Lippincott Company, 1945.

is present. In these cases there is a potential hope of improvement. It is obvious that any patient who has a correctable defect underlying the scoliosis should be treated for that defect.

Treatment

There is no rigid type or method of therapy that is applicable in every case of lateral curvature of the spine. When such measures are indicated, factors that create poor body mechanics and faulty spinal attitude must be corrected by surgical methods. Patients with structural changes are probably all candidates for surgical therapy. The relatively conservative treatment that is described here is applicable in cases of scoliosis without structural changes.

Shands[1] lists six basic principles of treatment:

1. To prevent the increase of scoliosis, when the tendency toward curvature is recognized at an early age.
2. To overcome the rigidity of the spine, when the deformity has become established, by means of mobilizing exercises.
3. To secure as much correction of the deformity as possible.
4. To develop sufficient muscle strength to maintain the correction.
5. To supply artificial support of the spine when the muscle strength is inadequate to maintain the correction.
6. To prevent overfatigue and other deleterious influences which might lead to an increase of the curvature.

These reasonable and logical principles are followed in conservative treatment. The patient is first subjected to a testing or grading of all muscles. This procedure, in addition to determining weakness, will serve also as a basis for future comparison of muscle capacity.

Depending on the results of the muscle testing, appropriate muscle exercises are prescribed which serve not only to strengthen weakness but to loosen up the curved portion of the spine to permit it to assume a corrected position with the aid of a brace. Exercise of the muscle structures involved is continued daily within the fatigue tolerance of the patient. The object is to gain the greatest possible permanent improvement while gradually discontinuing the artificial support. With this type of therapy, it must be borne in mind that muscle capacity is capable of utilization of certain reserves but is not without limitations. A muscle has a capacity beyond which it cannot function.

The Brace. — The brace that we are advocating is basically a Magnuson type.[8] The joints, however, are not fixed but are mobile. A hip saddle is built on both sides along the lower bar to conform to the contours of the patient's hips (figure). There are two pressure pads on the lateral surfaces which exert direct pressure on the sites of greatest deformity. Flexible pressure is controlled by a pressure scale spring which exerts force through the medium of cables strung through lateral pulleys. The pressure may be adjusted under the fluoroscope. The brace is made of aluminum and has the advantage of lightness and the x-ray visual qualities of aluminum.

The purpose of this brace is to exert a direct, flexible pressure to assist body reserves to restore and maintain a normal spinal attitude. More important is the development and maintenance of the best possible correction, so that the brace can gradually be withdrawn.

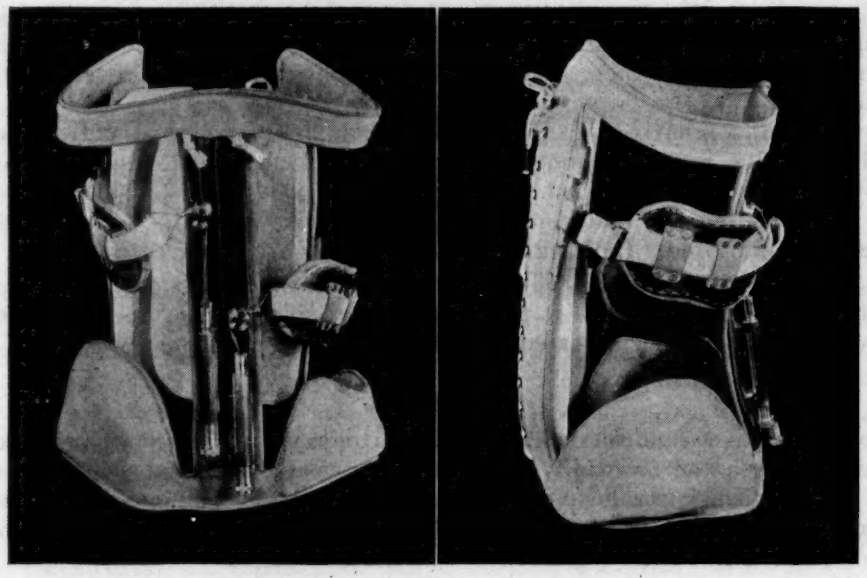
Comment

A multiplicity of machines and methods have been devised to restore normal anatomic relationships to the structures that constitute the spine.

8. The brace was designed and produced in the brace shop, Walter Reed General Hospital, under the technical supervision of Mr. John Hauser.

Frequently patients selected for therapy by means of external force have been those in whom vertebral growth was complete and structural changes had already taken place with extreme fixation of the spine. Failure was the logical result because distortion and rotation of vertebrae are changes that are not easily, if at all, reversible. The method of treatment described will produce best results when patients are treated early, when there are no structural changes in bone and before vertebral growth is complete.

The complex anatomy and physiology of the spinal structures, along with their inaccessability, make the use of mechanical aids difficult. The brace



Rear (left) and side (right) views of the brace.

described was devised in an attempt to exert a beneficial assistive pressure on the spine, to be used in conjunction with therapeutic exercises.

It is rather difficult to evaluate statistics on claims for correction of lateral spinal curvatures either by surgery or by conservative means because results that may honestly be called good on immediate observation often become failures after a longer period of observation. For this reason, it is mandatory to follow up all treated patients and warn them of the possibility of this hazard.

The methods of therapy used in this conservative approach are most applicable preoperatively in cases of lateral curvature selected for fusion because of congenital defects, structural changes or other reasons. Steindler[9] has stated that:

1. When fusion was performed without preoperative compensation the deformity relapsed so that there was hardly any improvement after five years or more.
2. When fusion was performed after preoperative compensation in 109 cases the correction was maintained under observation of five years or more.

This shows that preoperative correction is an absolute necessity for the end results.

Extremes of therapy have been recommended for scoliosis. At one extreme, conservative therapy only is recommended, on the assumption that body mechanics is deranged and that stabilization or fusion of one segment of the spine will create a new problem of balance for the spinal components.

9. Steindler, A.: Orthopedic Operations, Springfield, Ill., Charles C Thomas, Publisher, 1940.

It is well to point out here that we consider conservative therapy most applicable to functional or false scoliosis. Fusion may well be indicated in the organic structural type. For example, scoliosis caused by a short leg must have appropriate corrective treatment. We realize that the treatment of scoliosis is a debatable subject. It is our opinion that the conservative therapy that we have described is indicated in every case of functional scoliosis without structural changes. The ideal of treatment is to develop a permanently straight spine. Our efforts frequently fall short of this goal. Any improvement or even the prevention of further deformity is worthy of our effort. Conservative therapy is indicated to loosen a fixed spine and develop best possible position prior to spinal fusion for lateral curvature. Conservative therapy is indicated as a postoperative measure in these cases to maintain position and to prevent further distortion.

We realize that one cannot promise complete cure to a patient with scoliosis. The prognosis must be guarded until an actual result has been accomplished and maintained.

It is our opinion that conservative therapy is worthy of extended trial when it is indicated. Indications, in our opinion, are:

1. Functional scoliosis without structural changes; (2) organic scoliosis with structural changes as a preparation for spinal fusion, and (3) lateral curvature that has been treated by spinal fusion.

Summary

Scoliosis is a condition which is not uncommon, which occurs at an early age in children and for which in about 80 per cent of cases no definite cause can be established. On the average, vertebral growth is complete in girls at 14 years and in boys at 16 years. It is therefore most important that deformity be discovered before this growth is complete.

Muscle grading, correction by means of a brace and muscle development while the brace is gradually removed comprise a method of applying a corrective force to reestablish correct spinal attitude in cases of scoliosis without structural change. This method is also applicable in cases selected for spinal fusion to develop the greatest possible preoperative compensation of the spine and to maintain results postoperatively that have been accomplished by surgery.

Conclusions

1. Scoliosis is a lateral rotary curvature of the spine. Idiopathic scoliosis is that type of which no cause is discovered to explain the condition.
2. Scoliosis, without structural changes, may be treated in a conservative manner.
3. Muscle testing, the application of a brace, the development of muscles by a planned, continuous program and gradual withdrawal of the brace are recommended.
4. The program must be within the fatigue tolerance of the patient and the capacity of muscle reserve.
5. Conservative therapy may well be utilized to prepare patients with scoliosis for spinal fusion when indicated. It is available for postoperative cases of spinal fusion.
6. Conservative therapy of lateral curvature of the spine must be judged by time, diligent application of the method and honest evaluation of the results.

THE CARE OF PARAPLEGIC PATIENTS FROM THE VIEWPOINT OF INTERNAL MEDICINE *

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CHICAGO

An internist participating in the care of hospitalized paraplegic patients finds that his efforts gravitate into three main channels. The first, and most turbulent, is his contribution to the diagnosis and treatment of problem illnesses as they arise. The second — a natural outflow from the first — is the interest he develops in measures directed toward the prevention of such intercurrent illnesses. The third, which spreads out to communicate freely with the first two channels and with similar enterprises of other specialties, is his part in the promotion of investigational work, applicable to these patients from the standpoint of internal medicine.

Intercurrent illnesses of such a nature as to be brought to the attention of the consulting internist are not as frequent among the paraplegic patients of the Veterans Administration Hospital at Hines, Ill., as might be surmised. Some of the reasons for this will be brought out later, but it should be stated now that chief among these is the alertness of the regularly attending physicians to recognize and effectively deal with these diseases in their early stages. Alive to the ways in which early symptoms may be masked in paraplegic patients, they have acquired a remarkable ability to sense the importance of seemingly minor, or well concealed, symptoms and signs.

Diagnosis of disease is obscured by many factors referable to the spinal cord impairment. Visceral sensation is variably disturbed, often to such a degree that symptomatic localization of the trouble is completely unavailable. Muscular reaction to pain or to palpation may be greatly reduced or absent. From these standpoints, the diagnostic problem may be likened to that of the pediatrician whose very young patient can contribute little in the way of history or of logical reaction to examination. It becomes necessary to lean more heavily on objective measures than would ordinarily be considered good practice.

There is reason to suspect that in some instances even some objective evidences, such as the leukocyte reaction to infection, may be altered as a result of the spinal cord damage. Moreover, disturbed visceral function in a person with paraplegia (for example, the absence of diarrhea in conditions in which it should ordinarily be expected) can be most misleading. Extraneous signs and symptoms are almost invariably present as a source of confusion. The effects on temperature, blood count and sedimenation rate are among the more obvious examples of diagnostic discords set up by the almost inevitable urinary tract infection or decubitus ulcer.

Treatment of intercurrent disease is subject to many of the sources of confusion encountered in diagnosis, and these similarly affect the evaluation of response and progress. The choice of drugs or other measures is frequently modified by the presence of a complicating disorder related to the

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paraplegia which might render some therapeutic agents unsuitable. Sensitivities to certain drugs, particularly the sulfonamides, are more likely to be encountered in these patients, who have such extensive backgrounds of disease and treatment. There are, in addition, sometimes mechanical limitations in medical management resulting from the difficulty in the movement of patients or the achievement of favorable postural therapy.

It should be stated that one obstacle to treatment which might well be expected in these patients — the lack of desire to recover — is rarely encountered in this group. Customarily, the eagerness to recover from a pneumonia or nephritis and the willingness to cooperate to that end are fully equal to such responses in patients without paraplegia. On the other hand, as outgrowths of long invalidism and habituation to constant medical care and attention, there are occasional problems such as overcritical or overdemanding attitudes toward treatment. These must be handled in a manner best suited to the individual and are seldom insurmountable.

Prevention of illnesses in the paraplegic patients, aside from the obvious programs of immunization, sanitation and the like, rests predominantly on the maintenance of an optimum state of nutrition. This is by no means an easy goal, achieved merely by the provision of the adequate, tastefully prepared diet of 2,500 to 3,000 calories, high in protein and carbohydrates. The inactivity and boredom accompanying this form of disability are not conducive to good appetite, and the constant availability to the patients of candy, other sweets of all kinds and lunch counter snacks tends to produce at times a form of famine amidst plenty, which must be guarded against. Provision of extradietary sources of vitamins is encouraged, and this is accomplished for the most part by the administration of fortifying multiple vitamin capsules, with, of course, additional specific vitamin therapy, when indicated.

The general statement can be made that among these paraplegic patients nutrition is good. They do not exhibit the high incidence of hypoproteinemia sometimes described; in fact, blood protein levels are for the most part higher than average normal levels. This statement is based on a recently completed survey in which 1,172 determinations made on 150 paraplegic patients were reviewed. Significantly low levels were recorded for only 4 of these 150 patients. The question immediately follows: Why is hypoproteinemia not more prevalent? Certainly in the earlier stages following cord injury, during which seeping sores with leakage of serum proteins are active and while hypothalamic control of metabolism may be diminished, lowered blood proteins are to be expected and are reported. In these cases of longstanding cord injury, however, it has been suggested that this inhibition of protein metabolism may have subsided along with the return of autonomic power, thus permitting a rise of blood protein levels to normal or higher. An additional factor may be the lessened loss of protein from wound seepage in these later cases in which surgical treatment of decubitus ulcers and other methods to promote healing have been applied.

In further pursuit of an evaluation of nutritional status, 2,323 blood counts on 150 paraplegic patients were surveyed. In only 14 of these patients were evidences of anemia present, and for the most part these were indicative only of mild hypochromic microcytic types. Many factors beyond the provision of a well planned, attractively prepared diet, with supplementary vitamins, must contribute to this generally satisfactory state of nutrition. Among them, may be mentioned the excellent supervision provided by the urologic department in the care of urinary tract infections and the success attained by the surgical department in the operative treatment of many decubitus ulcers. These measures, together with the early recognition and treat-

ment of general medical illnesses, are important preventives of nutritional depletion. Less tangible, but equally important in the promotion of of a good nutritional state, are the factors of morale building and physical rehabilitation, brought about by the departments devoted to these activities.

Investigational studies directed toward clarification of some of the problems pertaining to internal medicine are not well enough advanced to warrant any far reaching conclusions at this time. Attempts have been made to correlate variations in recorded serum protein determinations, albumin-globulin ratios, blood counts and urinalyses with the levels of the lesions in the spinal cords. In November, 1946, Dr. Ayo compiled an impressive amount of data along these lines, but it cannot be concluded that any significant correlation was demonstrated. The chief enterprise at present is an effort to select investigational subjects that will be of practical value as well as of medical interest. Immense stores of data on the paraplegic patients in Hines Veterans Administration Hospital have been recorded in the charts, and it would be wasteful as well as negligent to fail to utilize this information as a prelude to further search. A systematic survey of the charts of all paraplegic patients in this group is now in progress. This will result in the marshaling of the following recorded data: gastric analyses; blood sugar determinations; glucose tolerance tests; febrile reactions to transfusions or plasma; leukocyte responses to infection; presence or absence of visceral pain; orthostatic variations in blood pressure; cold pressor tests; basal metabolic rates; motility of the stomach and intestine as described in roentgenologic reports; kidney function tests, and liver function tests. In each instance, the level of cord damage is taken into consideration.

Data obtained under many of these headings fail to offer significant information or stimulation to further investigation. Even such negative material, however, is useful as a means of eliminating, at least temporarily, unfruitful subjects for additional study. Preliminary returns on some phases of the survey, on the other hand, arouse curiosity and the desire for purposeful programs of investigation.

In 22 recorded gastric analyses, 13 showed complete absence of free hydrochloric acid. This markedly high incidence of achlorhydria calls for repetition of test meals on an extensive scale and will certainly warrant investigation if the apparent disproportion is confirmed.

Statistics on the manifestation of visceral pain consist chiefly of the recorded impressions of the staff physicians and are not based on any standardized tests or procedures. As might be expected, the available information is highly variable and sometimes contradictory. There is, however, repeated written comment on the appearance of cramplike pain during enemas in a considerable number of patients, most of whom had levels of injury in the dorsal portion of the cord. These impressions require clarification by the application of tests such as enemas, cathartics, air insufflation and similar precedures, carried out by uniform methods and technics.

Variation in blood pressure in response to postural change have been recorded in surprisingly few instances. This could well become a part of the routine examination of paraplegic patients and, with suitable elaboration, should produce highly interesting data.

Of 64 recorded basal metabolic rates, 39 were normal, 13 were definitely increased and 12 were well below normal range. It must be recognized that the patients tested cannot be considered truly representative of the paraplegic group as a whole, because of the undoubted presence of clinical symptoms which prompted determination of the basal metabolic rates. The same criti-

cism would apply to any attempt to draw general conclusions from many of the sources of information obtained in this survey.

The rate of gastrointestinal motility, as evidenced by the position of the barium column in a four hour film, received comment in 9 roentgen reports. Rate of progress through the small intestine was considered to be increased in 4 and normal in 5. Delayed gastric emptying time was mentioned only once in the survey, but the attending radiologists have stated that this is not an uncommon fluoroscopic observation. The rate of progress of orally ingested barium through the colon has not been studied. To the internist the motility of the digestive tract in the paraplegic patient is unquestionably a most fascinating subject, to which roentgen examinations could be highly contributory. Unfortunately, however, the paraplegic patient is not well adapted to gastrointestinal roentgen examination because of his inability to stand, to move readily or to endure much maneuvering on the fluoroscopy table. Moreover, his inability to defecate normally creates an additional problem in removal of the barium from the colon. It is therefore desirable to develop a well planned routine for this work on persons with paraplegia, designed to give the most useful information with the least disturbance to this type of patient. Films made at somewhat shorter intervals, continuing until the head of the barium column reaches the rectum, might become a part of such a routine.

Many subjects for prospective researches were not included in the survey because of the improbability that sufficient pertinent information would be contained in the charts. Problems involving extensive chemical, bacteriologic and other laboratory investigations remain for future consideration.

Worthy of repetition is the comment that in this large group of paraplegic veterans there is presented an exceptional opportunity as well as an exceptional obligation to extend to them the benefits of the advances in medical science in its application to their problems. The internist can hope to make a gratifying contribution through his participation in the prevention and treatment of intercurrent illnesses and in the furtherance of appropriate investigational work in his field.

Summary

1. Unusual difficulties are encountered in the diagnosis of intercurrent illnesses among paraplegic patients because of their disturbed visceral sensation and motor function and their impaired muscular reaction to pain and palpation. The customary presence of other disorders, such as decubitus ulcers and urinary tract infections, makes for further confusion.

2. Treatment of intercurrent diseases is hampered by the same factors and, in some instances, by the mechanical limitations imposed by paraplegic disability.

3. Prevention of illnesses is furthered by the good state of nutrition which prevails in this group of patients. An extensive review of laboratory data shows that blood protein levels, erythrocyte counts and hemoglobin determinations compare favorably with the normal values.

4. Investigational studies directed toward clarification of some of the problems encountered by the internist are contemplated. In an effort to select suitable subjects for such investigation, a survey of already recorded data is now in progress. From this survey it is becoming evident that gastric analysis, tests for visceral pain, orthostatic variations in blood pressure and gastrointestinal motility in paraplegic patients merit further study.

THE ROLE OF PHYSICAL MEDICINE IN THE LIFE HISTORY OF THE AMPUTEE *

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NEW YORK

It is said that Alexander the Great cried because there were no more worlds to conquer. The physiatrist can have no such complaint when it comes to the rehabilitation of the amputee. In the past the rehabilitation of the amputee was often incomplete. It is a fact, as Dr. Ficarra pointed out, "that . . . the day has passed when our duty terminates at the bedside of the amputee patient. . . . The amputation and prosthetic problems remain among our most creative surgical topics, preeminent from a combined medical, social and economic viewpoint. Today, the vision of medicine is panoramic. . . ."[1]

To anyone who has come into contact with many amputees throughout the years, it is entirely obvious that for the most part many of their problems have been delegated to the limb maker, and the limb maker is entirely unfitted to handle more than a small proportion of these problems. It might be said that the surgeon should concern himself more with the total rehabilitation of the amputee. However, in the light of much experience, one must look farther afield to find someone who is willing to take hold of this problem of amputee rehabilitation, both of the upper and of the lower extremity.

For a considerable time it has been my opinion that the burden of amputee rehabilitation from its very inception must rest squarely with you, the physiatrist. Apart from actual surgery and the mechanics of limb construction, the problem is essentially in the realm of physical medicine. Physical medicine must play an important role in bringing the amputee back to a satisfactory way of life. The problem is a complex one, and the physiatrist must, of necessity, be intimately acquainted with it. It is interesting to note that in a questionnaire sent to 128 above knee amputees, both veteran and nonveteran, by the Research Division of the College of Engineering, New York University,[2] more than 50 per cent stated that they had never learned to use their prosthesis properly; 95 per cent felt that they could considerably improve in the use of their prosthesis, and all of them stated that they had received no further training from the date of their discharge from the hospital or amputation center. The veteran group had received an average of 2.8 months training in the use of their prosthesis, while the nonveteran group had received an average of but 4.3 days of training. More than 58 per cent of the nonveterans stated that the training they had received was either fair, poor or worthless. These figures are extremely significant.

The life history of any amputee starts before operation and continues throughout life. The prosthetic problem is a continuous one. It must be considered as much more than the provision of an artificial substitute for a missing member. There must be smooth continuity from the initial step to the time when the patient achieves economic independence, each step

* Read at the Twenty-Fifth Annual Session of the American Congress of Physical Medicine, Washington, D. C., Sept. 9, 1948.

1. Ficarra, Bernard J.: Amputations and Prostheses Through the Centuries, M. Rec. 156:94, 154 and 239, 1943.

2. Report of Questionnaire Survey of 128 Above the Knee Amputees, No. 80-07, Research Division, College of Engineering, New York University, May, 1948, section BR 4.12, p. 2.

leading to and dovetailing into the next. There are seven basic phases in the rehabilitation of the amputee, and, although this statement applies to both leg and arm amputees, emphasis will be on the leg amputee because of limited time and space. These phases are (1) psychologic preparation, (2) surgery, (3) postoperative care, (4) preprosthetic training, (5) procurement and fitting of limb, (6) postprosthetic training and (7) prosthetic life. Each phase is important and neglect of any one of them may spell failure.

Psychologic Preparation

Psychologic preparation is, in my opinion, one of the most important and one of the most often neglected phases of such rehabilitation. It involves treating the entire person, rather than any one part. Amputation is not only a physical trauma but the deepest kind of psychologic insult. Proper psychologic preparation greatly softens this mental trauma. It imbues the patient with new hope for a future that will be livable and economically profitable. The theme in all this preparation should be, "amputees should not and need not be cripples." [3] This psychologic aspect of amputee rehabilitation is a part of every step on the road to recovery. Remember that the amputee knows nothing of what he may expect. You and your team must supply him beforehand with that knowledge.

I would say that the success of such rehabilitation will depend upon the right type of psychologic and physical training, correct stump preparation, prescription of the right type of limb with correct fitting, carefully planned training in the use of the limb, adequate follow-up and, last but not least, proper placement in the most suitable and gainful employment.

This psychologic phase must be carefully planned. Every means available should be employed, and the force of example of well adjusted amputees should not be overlooked.[4] It is realized that in some cases of acute trauma it may not be possible to spend much time on preoperative psychotherapy, but a briefing of the patient is necessary. He should be acquainted with all the steps in his rehabilitative process and must be made hopeful rather than despondent.

Surgery

It is not the purpose of this paper to elaborate on the surgical aspects of amputations. However, the physiatrist should be in a position to discuss with the surgeon the part which adequately planned surgery will play in the future prosthetic life of the patient. This includes, among other things, the proper type and site of amputation, treatment of the nerves and muscles and placement of the scar.[5]

Operative Care

It might be said that postoperative care is the concern of the surgeon, yet it is believed that here again the physiatrist, well acquainted with the entire problem, must play his part. In this phase, preventive measures are of the greatest importance. It is easier to prevent deformities than to correct them. Good bed posture should be insisted upon as well as the very early inception of extension-adduction exercises for above knee amputees and quadriceps exercises for below knee amputees. Consideration of the patient as a whole must be emphasized, for again psychosocial adjustment is a part

3. Shimberg, Mandell: Rehabilitating Men for Normal Living, The Crippled Child, 23:10, 1945.
4. Civilian Amputees in Action, Washington, D. C., Federal Security Agency, Office of Vocational Rehabilitation, 1948.
5. Shimberg, Mandell: The Amputee: What Should Be Done for Him? M. Bull. Vet. Admin. 19:428, 1943.

of this phase. Here the very important problem of stump conditioning is begun. The situation is paradoxic. On one hand, one seeks shrinkage of the stump, which is atrophy of tissue, and on the other hand one attempts development of the muscle fiber structure for good function. Atrophy appears quickly and is coincident with bed rest and the period of disuse. If a stump is left in disuse for a protracted period the activating stump-lever muscles undergo fatty degeneration and the muscle fiber structure is reduced in contractiiity. Yet, the by-products of surgery and a large amount of superfluous tissue must be got rid of. This is accomplished by planned pressure. Under proper care the skin will increase in thickness, the circulation will be improved and the muscles will increase in tone and volume. The stump will lose its abnormal sensitivity. I cannot agree with those who advocate self-bandaging, especially for above knee amputees. Bandaging accomplishes two purposes: (1) It supports the circulation, and (2) it brings the stump down to a shape suitable for the fitting of a prosthesis. However, I should like to warn that the old goal of a tapered conical stump no longer applies if the new type suction socket is used; in such a case a well muscled cylindrical stump is a better base for the prosthesis.[6] The utmost care and intelligence should be employed in stump bandaging, especially in above knee amputees. It should, whenever possible, be applied by a competent, trained therapist. Within ten days after operation unless there are complications the patient should be entirely turned over to the physiatrist and his helpers for further treatment. The surgeon has done his job, and it is now up to the physiatrist to carry through. It is in this stage that one must be especially careful regarding the indiscriminate use of wheelchairs, which in case of above knee amputees, may predispose to the development of postural abduction — external rotational contractures of hips, and in case of below knee amputees, to flexion contracture at the knee. I believe that it is good practice in this stage to mobilize the scar by friction massage. Whirlpool baths may be used to advantage in the treatment of terminal stump edema, which, in many cases, can be attributed to improper bandaging.

Preprosthetic Training

After about ten to fourteen days following operation, the patient is ready to enter the preprosthetic phase of his rehabilitation. This phase is by no means routine and varies greatly in different cases. The first duty of the physiatrist is to make a complete physiatric evaluation of the patient. The object, at this time, is to establish the need for, as well as the quality and quantity of, therapeutic exercise. No routine set of exercises can be prescribed, for there is no consistent pattern of muscle weakness. We must, of necessity, develop an accurate knowledge of each patient's body mechanics. Postural alinement of the body as a whole must be tested, and the plumb line test is of great value. Knowledge of all contractures in the vicinity of joints must be appraised. Furthermore, the muscle groups concerned with actuating the stump lever as well as other muscle groups should be tested for weaknesses. I use a simple chart to record the findings for both preprosthetic and postprosthetic evaluation. It is a record of the fundamental body mechanics of each individual patient and should be used until his discharge. It shows the site of amputation, history, type of prosthesis, roentgenologic and laboratory findings and the details of physiatric examination pertaining to the condition of stump, type of gait, etc.

One must correct defects in body alinement, establish muscle balance

6. Revised Report of the Suction Socket Above-Knee Artificial Leg Prosthetic Devices Research Project, University of California, April, 1948, p. 5.

and assure normal range of joint motion. It is important that attention be directed only to those muscles which require strengthening, to those joints which require further mobilization and to those defects in body mechanics which require correction. During this period attention should also be paid to maintaining the general body muscle tone.

Unless one knows the defects present and takes steps to correct them, the limb fitter is at a great disadvantage, in that he must fit the prosthesis to whatever deformity exists. Thus the patient is necessarily held in a position of deformity by his prosthesis. And let me say that this is a frequent experience encountered in prosthetic practice. It is necessary to prescribe accurately not only the type of exercise but the dosage, and this should be changed in accordance with the patient's response. In the rehabilitation clinic at the Veterans Administration Regional Office in New York, it is the practice to supervise carefully these exercises. It has been frequently pointed out by many observers that if one fails to stabilize the pelvis in hip extension exercises of the affected side of an above knee amputee, one will get pelvic tilt with hyperextension of the lumbar portion of the spine, thus exercising the erector spinae rather than the hip extensors. The need for careful supervision is obvious. One should strive especially for muscle balance and avoid exercising the antagonists of weak muscles.[7] It is not the purpose of this article to enter into technics, muscle positions and the like. I am merely attempting to lay down a sound fundamental basis for such therapeutic procedures, and I should like to emphasize the word "therapeutic." Time should always be allowed to correct defects and strengthen muscles before the patient is declared ready for prosthetic fitting. Fundamentals must appear simple to the expert, but it is my experience that unless particular attention is paid to detail, the amputee will not be adequately prepared for the next stage, the fitting of the artificial limb.

Here, again, the patient's psychosocial adjustment must not be neglected. He must be thoroughly acquainted with what we are trying to accomplish in order to secure his cooperation.

Procurement and Fitting of Limb

The amputee should expect from his doctor a realistic knowledge of prostheses. The doctor should be able to advise him as to what type of prosthesis will fit his own particular needs. It must be borne in mind that if the choice is left solely to the limb maker the patient will be bewildered by the many varieties and the different costs of artificial limbs. He needs the physician's advice, and the advice need not be extremely technical. Physiatrists cannot be expected to be limb makers, and yet they should have a basic knowledge of limb construction. I do not believe that it matters what make of limb is chosen, or of what material it is made as long as the final fit is satisfactory. I prefer willow wood. Some tailors can make a well fitting suit, and some limb makers can fit a good limb. I repeat that the physiatrist should be acquainted with the fundamentals inherent in limb construction, so that he may intelligently evaluate the artificial limb when worn by the patient. At first there are always adjustments to be made, but I believe it to be axiomatic that no artificial limb is right unless it feels comfortable to the wearer. I have never seen a patient who, given time, could not wear a limb in comfort.

There must be close coordination between the doctor and the limb fitter.

7. Rose, Donald L., and Soffe, George W.: An Analysis of Certain Procedures Employed in the Physical Medicine Treatment of Amputations, Arch. Phys. Med. 128:506, 1947.

Many times the surgeon will thank the doctor for taking over this part of his former job, which he seldom found time to do.

The patient has now been well fitted with his new prosthesis and is ready to enter into the next phase of his rehabilitation.

Postprosthetic Training

In the phase of postprosthetic training the patient needs careful guidance and much advice. The stump has now become an actuating lever, for it moves the leg. There is much that must be taught to the patient. First of all, he must be taught to care for his stump. Stump hygiene is of paramount importance, as well as the use and the care of stump socks. He must know how to care for his artificial leg.

The patient needs much encouragement. If he has been psychologically conditioned, he will not expect that his prosthesis will compare favorably with his missing member. Sometimes it will require all one's patience and ingenuity to condition him to his artificial limb. It is my belief, based on experience, that his phase of training should be gradual. The amputee must learn to walk once again, and I emphasize the word "learn." Furthermore, he must walk as nearly normally as possible.

There are several components of good walking with a prosthesis: balance and muscle coordination, smooth walking rhythm and equal length of steps. The patient must learn weight distribution and how to adjust the travel pattern of the prosthetic foot, so as to duplicate that of the normal foot. He must develop proper kinesthetic sense, so that at all times he knows where the artificial limb is. Furthermore, he must learn to achieve a uniform stride. He must be warned at the onset to go slowly with the wearing of his prosthesis or edema of the stump and pressure sores will develop. A new car must be driven slowly for the first few hundred miles, and a stump lever must equally be used sparingly for a period of time. Adjustments will have to be made to the artificial limb from time to time. Further, marked shrinkage of the stump will appear as a result of walking. This will cause the patient to sink abnormally low in the socket of the artificial limb. You must know when an additional stump sock is needed or a liner required in the socket of the artificial limb. In this stage, I emphasize the close coordination between the limb fitter, the doctor and the patient.

Now is the time to think with more urgency of the patient's future occupation. It will be necessary after a period of training to evaluate his gait. Briefly, there are four important parts in the analysis of this gait: (1) weight bearing on the prosthesis, (2) motion of step with the normal leg, (3) weight bearing on the normal leg and (4) motion of step with the prosthesis.

Each of these should be analyzed separately when an awkward gait or limp develops, to determine which is responsible. It must then be corrected. An excellent guide here is the War Department Technical Manual TM 8-293.[8]

Some of the things to be watched for are side sway of hip, lateral tipping of pelvis, faulty timing of heel contact and excessively long prosthetic steps. There is much to evaluate and to correct.

No amputee's training is complete until he is taught to dance. The coordination and confidence engendered by dancing cannot be equalled. It also adds greatly to rhythm and balance, and to psychosocial adjustment.

8. Physical Therapy for Lower-Extremity Amputees, United States War Department, Technical Manual 8-293, Washington, D. C., Government Printing Office, 1946.

Prosthetic Life

The patient is now ready to enter into what I call his prosthetic life. He has passed his training period successfully and is ready for placement in a suitable job, but the task is not ended. It will be up to the physiatrist to follow through, for many things may occur. For example, hard edema may develop at the end of the stump, usually owing to stump choking and the result of a constriction caused by the artificial limb. Each condition must be diagnosed and corrected. There are many things which happen to a stump, and again one must know what may go wrong and the indicated treatment.

New Developments

In this scientific age, and especially for the next few years, many new developments are on their way in the field of prosthetic appliances. For example, the suction socket, which holds the limb to the patient by negative pressure rather than by any mechanical means, is being carefully evaluated and is in the testing period. I want to emphasize that it has not as yet been accepted. Should it be accepted by the Committee on Artificial Limbs of the National Research Council, it will be available for general use. This will bring up new problems for the physiatrists to solve. New hydraulic legs with positive control by muscle activation are being studied, and the physiatrist may be faced with the problem of developing these actuating muscles. I point these things out because the field of prosthetics, which was nearly static for so long, is now alive with new possibilities and even probabilities.

Upper Extremity Amputations

The problem of rehabilitation in case of an upper extremity amputation again belongs in the field of physical medicine. It differs materially from that of rehabilitating the lower extremity amputee. In the latter, one is dealing essentially with weight bearing, and the stump lever is of the greatest importance.

In the upper extremity the complex functions of grasp and touch are involved, and preparation of the stump is simple except in case of cineplasty. The actual hand and arm function can be only crudely imitated by the prosthesis. It is a truism that one must fit a leg to the stump but an arm and hand to the patient himself. The upper extremity prosthesis is, after all, but a tool, and considerable training prescribed by the physiatrist and carried out by the occupational therapist is necessary to make the amputee adept in the use of the prosthesis. War Department Technical Manual 8-290 deals excellently with many of these problems.[9]

A word must be said about cineplasty. It has a definite place, and again the actual needs of the patient must be considered. The proper development of the muscle motors is the concern of the physiatrist.[10]

A tremendous development has occurred and is occurring in the available types of upper extremity prostheses. The types which have been accepted for use include the Northrop Above Elbow Arm as well as the Pronator and Supinator Wrist for below elbow amputees and the Hosmer and the Fitch Elbow for above elbow amputees.

Rapid developments are proceeding in the field of upper extremity prostheses. The Army Prosthetic Research Laboratory is testing a new hook

9. Occupational Therapy, United States War Department, Technical Manual 8-290, Washington, D. C., Government Printing Office, 1946.
10. Kessler, Henry H.: Cineplasty, Springfield, Ill., Charles C Thomas, Publisher, 1947, pp. 171-184.

and hand, as well as a lifelike cosmetic glove. The goal is to construct a prosthesis which will have a realistic cosmetic appearance in addition to real utility based on the patient's requirement.

Conclusion

In conclusion, I wish to emphasize that physical medicine plays a major role in the life history of the amputee. It is the responsibility of the physiatrist and his team to shoulder the burden of amputee rehabilitation. The surgeon, in most instances, has not been able to find the time to supervise this rehabilitation, and the limb fitter to whom it was most frequently assigned is not capable of assuming the responsibility. It will be a triumph for the physiatrist if he can carry the amputee from helplessness to full economic activity.

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Discussion

Dr. Robert Dow (Bethesda, Md.): Dr. Shimberg has presented the type of paper so greatly needed in the field of amputee training, the practical, how to do it paper.

The problem of amputations in civilian practice is not recognized as it should be. There is an increasing tendency toward limb loss with increasing age of the population, and I fear that there have been many more amputees than the medical profession would care to admit, lying around without prostheses simply because they have not been trained in its use. I do not believe that the New York University figures cited by the author regarding the satisfaction of amputees with their prostheses would apply over the country, but the point that he was making was well taken — that much more care and attention to the training than heretofore given are needed.

I am pleased that he mentioned friction mobilization of the scar of the stump. In the past that was a very controversial subject, but the method is valuable and may help to keep these people in their appliances and so that they can go about their business.

Another important question is new developments in prostheses, compelling physiatrists to stress complete restitution of function everywhere. At one time, some people had a rather limited idea of the forearm prosthesis and the possibilities in the postoperative care of the arm amputee. They did not maintain pronation and supination, and, with some of the new arms, possession of those functions is a very important factor.

Dr. Shimberg indicated, but did not specifically mention, I believe, the question of very early use of static exercise in the immediate postoperative period. This is a valuable measure to get the patient established on a rehabilitation program.

Dr. Shimberg (closing): I am not certain that I mentioned the fact, but I do believe in very early exercise, almost the day after operation, since establishment of that exercise and orientation of the patient in doing it are most important.

MEDICAL NEWS

Dr. Krusen on Panel Discussion

The second annual meeting of the College of American Pathologists was held in Chicago, Oct. 11-13, 1948. One of the round table conferences was devoted to pathology, radiology, anesthesia and physical medicine. Dr. Frank H. Krusen represented physical medicine on the panel discussion of this particular conference.

Dr. Watkins Joins Baruch Committee

The Administrative Board of the Baruch Committee on Physical Medicine announces the appointment of Dr. Arthur L. Watkins of the Massachusetts General Hospital as Assistant Director of the Baruch Committee.

Dr. Kendell on Mission to Pacific Area

Dr. H. Worley Kendell of the University of Illinois College of Medicine has been appointed expert civilian consultant to The Surgeon General, U. S. A., for a medical mission to the Pacific area. Dr. Kendell is a member of a team of physicians which left the U. S. on Nov. 2 to visit Army hospitals in Hawaii, the Philippines, Guam and Japan, The purpose of the mission is further to promote and improve the quality of medical care in Army medical installations. Consultants participating in the mission will assist and advise theatre surgeons and the hospital staffs in the treatment of patients.

The participants will conduct clinics, make ward rounds, give lectures, and perform other teaching functions that may be required. Following the completion of the mission, the participants will forward their reports to The Surgeon General, U. S. A.

Dr. Lenox Baker in Korea

On August 11, the Army medical officers stationed in Korea met at the 34th General Hospital and were addressed by Dr. Lenox K. Baker of Duke University College of Medicine, Durham, N. C., who is touring the command as a consultant in orthopedic surgery. Dr. Baker lectured on "Low Back Pain" and made ward rounds.

Fellowships in Physical Medicine Available

The Baruch Committee announces that additional funds have been made available for fellowships in physical medicine. Applications should be made to the Baruch Committee on Physical Medicine, 597 Madison Avenue, New York 22.

New York Society of Physical Medicine

At the regular monthly meeting for November the New York Society of Physical Medicine presented the following program:

Symposium on Arthritis. — (1) "Basic Therapy and Supplementary Measures in the Treatment of Arthritis," by Otto Steinbrocker, M.D., Associate Clinical Professor of Medicine, New York University (by invitation); (2) "Orthopedic Management," by Robert L. Preston, M.D., Clinical Professor of Orthopedic Surgery, Post-Graduate Medical School (by invitation); (3) "Roentgen Therapy in Arthritis," by Harold W. Jacox, M.D., Professor of Radiology in College of Physicians and Surgeons, Columbia University (by invitation), and (4) "Anti-Rheumatic Drugs," by Charles Ragan, M.D., Assistant Professor of Medicine, Columbia University (by invitation). A general discussion of physical measures followed.

Pennsylvania Academy of Physical Medicine

At a meeting of the Pennsylvania Academy of Physical Medicine, October 21, 1948 at the University of Pennsylvania Hospital, Philadelphia, Pennsylvania, Dr. Robert Hodes presented a paper on "Electromyographic Patterns Following the Billig Procedure (Neurotripsy) in Chronic Poliomyelitis." The paper was discussed by Dr. Donald Jones and Dr. Burton Chance, Jr.

A Fourth Seminar on Physical Medicine at Galveston

The Medical Branch of the University of Texas is arranging the holding of the fourth seminar on physical medicine at Galveston during the first week of March, 1949. Judging from the great interest shown in this annual event and remembering the fine hospitality of the medical faculty at Galveston, physicians and physical therapists not only from the Southwest but from all parts of the United States will want to enroll again. Watch the ARCHIVES for announcement of the program. For further details address Dr. W. A. Selle, Professor of Physiology, University of Texas, Medical Branch, Galveston, Texas.

Courses in Radioisotopes

The Oak Ridge Institute of Nuclear Studies announces that three additional radioisotope courses have been scheduled as follows: Jan. 3, 1949, government personnel; Feb. 14, 1949, medical personnel, and March 14, 1949, general. Thirty-two participants will be accepted in each course, and the four weeks' period will be divided into laboratory work, lectures on laboratory experiments,

(*Continued on page 731*)

ARCHIVES of PHYSICAL MEDICINE

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.·. EDITORIALS .·.

Frank Henry Ewerhardt — 1877-1948

FRANK H. EWERHARDT: EDUCATOR AND HUMANITARIAN

Dr. Frank H. Ewerhardt, 71, Past-President of the American Congress of Physical Medicine, Past-President of the American Society of Physical Medicine, member of the Executive Council of the Congress and member of the board of the Registry of Physical Therapy Technicians, died in St. Louis, October 15, of leukemia. On July 1 he had retired from active association with Washington University and affiliated institutions, an association which had been continuous since 1904, and had received the titles of Assistant Professor Emeritus of Physical Therapy, Washington University School of Medicine, and Emeritus Chief of Physical Medicine of the St. Louis Children's Hospital, Barnes Hospital, McMillan Hospital, Maternity (St. Louis) Hospital and Washington University Clinics. In 1946 he had retired as Director of Physical Education and Director of University Health (with rank of Professor), Washington University.

Dr. Ewerhardt was born in Sheboygan, Wis., on Jan. 25, 1877. Graduated from the New Haven Normal School of Physical Education, he went to St.

Louis in the early 1900's as Director of the Gymnasium and Athletics of Smith Academy. In 1904 he joined the staff of Washington University as Director of Physical Training, a position he held until 1913. During this time he enrolled in the School of Medicine and received his medical degree in 1910. In 1913 he joined the medical faculty as Assistant in Anatomy; in 1915 he transferred to the Department of Medicine, and in 1922 he received his first appointment in the Department of Physical Therapeutics. From 1933 through 1946 he was Director of Physical Education and Director of University Health. A firm believer in amateurism in college athletics, he played a prominent role in keeping the university football free from professionalism; he was also a leader in the founding of the Missouri Valley Conference.

Dr. Ewerhardt was a frequent contributor to periodicals in the fields of medicine and physical education. In association with a former student, he wrote "Therapeutic Exercise," which was published in 1947 and has become widely used as a textbook. He contributed the chapter on the "Use of Heat and Cold" in "Principles and Practice of Physical Medicine," edited by Pemberton, Mock and Coulter, and the chapters on "Physical Exercise" and "Posture" in Glasser's "Medical Physics."

His leadership in the field of physical medicine was recognized by the government during the two world wars. In World I he was ordered to remain with the staff of Barnes Hospital to teach physical therapy to medical officers. During World War II he was the Health Officer in Charge, U. S. Army Hospital, Washington University. In April, 1946 he was appointed Consultant in Physical Medicine Rehabilitation, Veterans Administration, Branch Office No. 9. He was Consultant to the Council on Physical Medicine of the American Medical Association. In 1945-46 he was a member of the Sub-Committee on Physical Therapy of the National Research Council. He was also a member of the original American Board of Physical Medicine, having been certified in 1947; Fellow of the American Association for the Advancement of Science, and member of the national science honorary society, Society of Sigma Xi. At the Twenty-Sixth Annual Session of American Congress of Physical Medicine he was awarded the Gold Key "in recognition of long and distinguished contributions to the field of physical medicine."

Dr. Ewerhardt was married on Aug. 23, 1904, to Miss Jessie Crankshaw, who with their two children, Karl F. Ewerhardt, of St. Louis, and Mrs. Glen Irwin, of Decatur, Ill., survive him.

MELLON INSTITUTE HOST TO BRACE MAKERS AND PROSTHETIC TECHNICIANS

The prescription and knowledge of braces and prosthesis is coming more and more into the field of physical medicine. Consequently, a recent symposium at the Mellon Institute is of interest.

This symposium, the week of September 20, 1948, sponsored by the Department of Orthopedic Surgery of the University of Pittsburgh Medical School, The Sarah Mellon Scaife Foundation Fellowship on Orthopedic Appliances and the Orthopedic Appliance and Limb Manufacturers' Association was held at the Mellon Institute. This, the first meeting of its type, was arranged for brace makers and is an illustration of the increasing interest of brace makers and prosthetic technicians in knowing more about the medical problems related to their profession and, particularly, a desire for a better understanding of anatomy and physiology to enable them more efficiently to

prepare braces and prosthetic devices. The objectives of the meeting were to survey the basic sciences in relation to bodily deformities, including anatomy and physiology in aspects related specifically to braces and indirectly to other orthopedic appliances; to apply the above principles to brace design and construction, and to emphasize the desirability of cooperation between the surgeon, appliance maker, the mechanical engineer and patient, stressing the application of engineering design, metallurgy and chemistry to this field.

The lecturers were orthopedic surgeons, physiatrists, anatomists, scientists, engineers and orthopedic technicians. The subjects were presented through demonstrations, discussions and field trips covering a wide scope of specific subjects directly related to the prosthetic and orthopedic appliance industry. The excellent esprit de corps prevalent during the entire meeting was an expression of the desire of this group of men to gain further knowledge in order to do a better job and to work more closely with the medical profession. Furthermore, they are eager to have a formal educational curriculum established under the auspices and standards of a university.

A rehabilitation symposium also was presented by Drs. Donald Covalt and Henry H. Kessler and Mr. Michael Shortly at the meeting of the Orthopedic and Limb Manufacturers' Association, which featured the medical aspects of the industry and the importance of a better coordinated program for the benefit of the handicapped.

A second symposium was presented on the suction socket prosthetic program. To date, the results of this type of prosthesis for above the knee, unilateral amputees have been about 85 per cent satisfactory. This prosthesis permits the amputee to use all ranges of motion of the hip joint and with proper training should materially increase the function of the artificial limb. Although the development of this type of artificial limb is in its infancy and it may be a few years before it is widely prescribed, physiatrists should equally understand the principles and problems if they are successfully to prescribe the training program for therapists. This further emphasizes the need for better integration of the physiatrists with those organizations dealing with the problems of the handicapped.

This was a very interesting and instructive meeting. The members of this organization are obviously eager for the cooperation of the medical profession. A closer integration for mutual interest is needed. They appreciate the rapidly growing interest in physical medicine but it is up to each of the physiatrists in their respective areas personally to assist in keeping the interested members informed concerning developments in this field. To date, they are uninformed with regard to the objectives and development of the field of physical medicine. They appreciate the value of physical medicine as it relates to the proper fitting and use of braces and prosthetic devices but their limitations and responsibilities to the patient and physiatrist need more specific definition.

Physiatrists should be aware of the existence of the American Board for Certification of the Prosthetic and Orthopedic Appliance Industry, Inc. This organization was incorporated in August, 1948. Some of their objectives are to encourage and promote high standards of workmanship and service and the maintenance of adequate facilities and the use of adequately trained personnel; also to promote the welfare of the physically handicapped by establishing professional standards for those engaged in the fitting of prosthetic or orthopedic appliances, particularly with respect to adequacy and cleanliness of facilities and proficiency and honesty in service rendered, and with the object of discouraging the practice of this profession by unqualified persons. They further aim to establish standards applicable to individuals en-

gaged in the profession of fitting prosthetic or orthopedic appliances, and corporations, partnerships, individuals and others engaged in or desiring to enter in the business of fitting prosthetic or orthopedic appliances. They also intend to conduct investigations or examinations to ascertain whether these standards are maintained.

The Mellon Institute, in the establishment of a fellowship for research in orthopedic appliances, has added another star to its crown of accomplishments. Dr. Edward R. Weidlein, Director of the Mellon Institute, announced this comprehensive multiple research fellowship on orthopedic appliances by the Sarah Mellon Scaife Foundation of Pittsburgh in September, 1947. The program is planned and carried out for the benefit of mankind through the medical profession. Under the guidance of orthopedists and with the cooperation of leading organizations in the field, as well as of manufacturers of orthopedic appliances, the fellowship conducts broad scientific investigation and developments relating to such appliances. Particular attention is accorded problems of mechanical design, improvements in materials of construction and methods of fitting braces and similar orthopedic devices.

John L. Young, Ph.D., heads the program as Senior Fellow. A research specialist in metallurgy and mechanical engineering, he has been active on the investigatory staff of Mellon Institute since 1928. Eugene F. Murphy, M.E., Staff Engineer, Committee on Artificial Limbs, National Research Council, Washington, D. C., serves as Advisory Fellow. Several research assistants complete the personnel of the fellowship, whose adviser on the Executive Staff of the Institute is George H. Young, Assistant Director. The medical advisory committee of the fellowship is under the chairmanship of Paul B. Steele, M.D., Professor and Head, Department of Orthopedic Surgery, School of Medicine, University of Pittsburgh. The other members of this committee at the inception of the work were John A. Heberling, M.D., Associate Professor of Orthopedic Surgery, and Carl C. Yount, M.D., Assistant Professor of Orthopedic Surgery, in the same institution.

The first year of this fellowship has seen many accomplishments and has established this important fellowship as one of marked importance not only to the orthopedic surgeon but also to the physiatrist. The assistant director, George H. Young, has expressed his willingness to cooperate with and assist physiatrists in every way possible in special projects in which these seems to be a mutuality of interests. The Mellon Institute welcomes visitors, particularly to see the development of this fellowship. It has much to offer the physiatrist interested in improving the present or developing new apparatus toward better rehabilitation technics for the handicapped.

FRANK H. EWERHARDT MEMORIAL FUND

A fund to be known as the Frank H. Ewerhardt Memorial Fund has been created for the opportunity of helping to keep Dr. Ewerhardt's name, and thus his spirit of activity and helpfulness, alive.

All such funds should be made payable to and sent to Robert A. Moore, M.D., Washington University School of Medicine, Euclid Avenue and Kingshighway, St. Louis 10, Missouri.

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general background lectures and special topic seminars. Information may be obtained from Dr. Ralph T. Overman, Special Training Division, P. O. Box 117, Oak Ridge, Tenn.

Schools for Physical Therapy Technicians

There are 25 approved schools, with 1 new school approved in 1947. Twenty-one schools reported a total of 383 graduates of their regular courses. Ten schools offering advanced courses reported satisfactory completion of these courses by 20 students. The reports anticipate an approximately equal number of graduates in 1948.

Entrance requirements include graduates of accredited schools of nursing graduates of physical education courses or collegiate training including science courses. Eighteen of the schools admit nurses, 15 accept physical education graduates and all but 2 of the schools will permit college students to enroll in the one year curriculum. The list of schools requiring college training for admission contains 14 that specify three years of college credits, 10 which mention two years of credits, and 4 that require a degree. A total of eight courses are combined with college curriculums, so that high school graduates can obtain a degree in physical therapy after four academic years of study. All but 7 of the schools offer college credits, although 2 schools which list two courses state that only one course will permit the student to accumulate college credit.

The length of training is twelve months in most instances, but 3 schools require fourteen, fifteen and twenty-four months respectively for the regular course, while high school graduates must complete the four year program.

Technical Personnel

The need for more technical personnel in hospitals, clinics and physicians' offices continues and in some quarters has been termed "critical." The relation between the number of admissions to hospitals and the requirements for full time trained technicians has been demonstrated by statistical comparison. Most hospitals, and many with greatly increased facilities through new construction, are operating at capacity. The present general tendency toward shorter periods of convalescence in hospitals has permitted a greater turnover of patients than in the past. Progressive advances in therapy, new methods of treatment and rehabilitation have created new demands for technical personnel. These demands have been further augmented by the increased needs of government hospitals, particularly those of the Veterans Administration. Federal agencies that are interested in maintaining adequate standards in the training of technical personnel share the general concern over the shortages and are actively engaged in measures designed to increase enrollment and encourage the development of new schools. The number of technical schools approved by the Council on Medical Education and Hospitals and the number of graduates from these schools have increased each year, but are still insufficient to meet current needs. The present lists of approved technical schools include seven new schools of occupational therapy, forty-four schools for clinical laboratory technicians and fifty new schools for x-ray technicians. Schools for physical therapists and for medical record librarians have not increased proportionately. The solution of the problem lies in increasing enrollment in presently approved schools to acceptable capacity and in the development of new schools by those universities, colleges and hospitals that can provide adequate facilities and qualified teaching personnel. These should be developed in accordance with the essentials for approval as outlined by the Council on Medical Education and Hospitals.

Employment of the Handicapped

National Employ the Physically Handicapped Week which began October 3, was set aside by President Truman to call attention to the courageous efforts of many disabled persons and to dramatize the activities of organizations engaged in rehabilittion. Repeated studies and demonstrations have shown that the physically handicapped employee is as dependable and productive as his normal co-worker and in many cases even more so. We are still a long way from furnishing maximum medical and vocational rehabilitation services to all who are in need, and of accepting the physically handicapped socially, vocationally and economically on the basis of their abilities rather than their disabilities. The increasing participation of both employers and social agencies in the observation of National Employ the Physically Handicapped Week demonstrates that both industry and the public are beginning to understand that hiring the handicapped is good business.

Hadassah Medical Organization

The ARCHIVES is indebted to Dr. Richard Kovács for permission to publish the following letter from Jerusalem.

Jerusalem, Aug. 31, 1948.

Dear Dr. Kovács:

Many thanks for your letter of June 30, 1948, which reached me about ten days ago, but I did not want to answer it until today, as it happens that yesterday at last we succeeded in opening the Rehabilitation Center branch of our hospital and we have been very busy in getting it in working order. Besides that, I wanted to inform you this time of the first big step on the road of reconstruction which we hope, will be followed by others on nonmedical lines.

As I read your letter, it is quite unbelievable what we have been going through since January,

when I wrote my last letter to you. Since then we lost — we hope temporarily only — our pride, the modern big hospital of ours, on Mt. Scopus, after a big convoy of vehicles, carrying 120 scientific workers of the Hebrew University and Hadassah, was ambushed and all but 20 persons slaughtered, April 13. We had to build out in town, in requisitioned buildings and monasteries, our network of different departments, especially surgical, since after the winding up of the British mandate the fighting in and out of the town intensified to such a degree that during the worst first 28 days of the siege of Jerusalem (about 90,000 inhabitants within the city boundaries) the various stations and hospitals had to take care of approximately 5,000 casualties. With the most superhuman efforts, the task of providing the best possible aid for our wounded was carried out amazingly well. Almost all the doctors had to change into surgical work, and I myself was in charge of a 60 bed section of a big surgical department. For you it must be unbelievable if I write that in the third week of the siege our stocks of penicillin were almost, and our stocks in ether and antitetany serum completely, gone. The food ration of the civilian population was approximately 700 calories a day and hospital patients got no more than 1,100. Even in these circumstances we found opportunity to begin with physical medicine treatments in the early days after admission, although we have been badly understaffed and the personnel extremely overworked and overstrained. Electrical treatment could not be carried out, because there was no supply of current; and even water was scarce, as a person's daily ration was 5 to 10 liters of water. Still, we lived through all the shelling, and we are no more isolated from the outside world. Our supplies are sufficient. At last we could sit down to rehabilitation. This was done already in other parts of the country, but, as Jerusalem has still to be self supporting, it was decided to build a center with 50 beds at present, which is to be extended later. There is a section of orthopedics, neuropsychiatry and physical medicine (in the last of which Dr. E. Adler and I are working) with services of occupational therapy, social rehabilitation, and so many smaller factors provided, which must characterize the spirit of a center of this kind.

It must be emphasized that the special conditions of the country, especially the relatively small distances within one or the other front, created a special material for the hospitals. Because of these small distances and the speedy transportation of casualties many lives could be saved, but, on the other side, many such casualties who would never have had a chance in any other battle fronts to survive, lived through but remained invalids, and I think that their percentage at the very last count will be larger; accordingly, the death rate from war wounds will be smaller than the average.

Still we are only at the beginning of our systematic work of rehabilitation in a center as such, and I shall be very grateful if you will be kind enough to assist with your very valuable advice, especially now, since Dr. Adler will leave for a while in Europe, I am left in charge of the section of physical medicine.

With many thanks for your kind encouragement, I am,

Very sincerely yours,
(Signed) Dr. I. Lyon.

Walter Hughson Honored

By action of the Council, American Speech Correction Association, in convention at Salt Lake City, Utah, Dec. 31, 1947, the Association voted unanimously that the Honors of the Association for distinguished contribution to the field of speech correction be awarded posthumously to Dr. Walter Hughson, a statement of this award to be published in the March, 1948, issue of the *Journal of Speech and Hearing Disorders,* together with a summary of the achievements for which the award is granted.

Director of Hospitalization Appointed

The Veterans Administration announces the appointment of Dr. E. B. Quarles, formerly associate director at Barnes Hospital, St. Louis, as director of the Veterans Administration Hospitalization and Requirements Service. He is a graduate of the Medical College of Virginia, interned at Nassau Hospital, Mineola, N. Y., and at the Essex County isolation hospital, Belleville, N. J., and then engaged in industrial and general medical practice at America, Ala. He served with the Medical Corps of the Army during World War II.

The Ranson Lecture

Dr. George M. Lyon, Washington, D. C., chief of the radioisotope section, department of medicine and surgery, Veterans Administration, delivered the Ranson Lecture on "The Radioisotopes in Medicine," October 22 at the Archibald Church Library of Northwestern University Medical School. The lecture was sponsored by the Theta Chapter of Phi Beta Pi Fraternity.

Indiana State Medical Meeting

The annual meeting of the Indiana State Medical Association was held October 26-28 in Indianapolis under the presidency of Dr. Cleon A. Nafe. Among the guest speakers was Austin M. Brues, Chicago, who spoke on atomic radiation in medicine.

Workshop for Cardiac Patients

The Galveston County Chapter of the Texas Heart Association has planned for hospital patients with cardiac disease a workshop designed to give training in various handcrafts which might lead to employment for persons whose heart conditions prevent them from returning to previous jobs.

BOOK REVIEWS

HUMAN NEURO-ANATOMY. By *Oliver S. Strong,* B.S., M.D., formerly Professor of Neurology and Neurohistology, College of Physicians and Surgeons, Columbia University, and *Adolph Elwyn,* B.S., M.D., Associate Professor of Neuro-anatomy, College of Physicians and Surgeons, Columbia University, New York City. Cloth. Price, $6.00. Pp. 442 with 336 illustrations, Williams & Wilkins Co., Mount Royal and Guilford Aves., Baltimore, Maryland, 1948.

This is the second edition of a universally accepted and acclaimed book by two well-established authorities in the field of neuroanatomy. Written in lucid style and concise language the book is replete with excellent illustrations emphasizing the functional and clinical significance of the structural anatomy and mechanisms of the central nervous system. One important addition is a new chapter on segmental and peripheral innervation with a clinical-anatomical discussion of the main peripheral nerves and nerve plexus in the body. A second addition of importance is the expansion of the chapter on the arterial and venous drainage of the brain which results in a more complete and fully illustrated account of the same than in the first edition. This book, as always, is indispensable to both student and practitioner and makes a fine contribution to the literature.

NATURE OF LIFE, A STUDY ON MUSCLE. By *A. Szent-Györgyi,* Professor of Biochemistry, University of Budapest. Cloth. Price, $3.00. Pp. 91 with 22 Illustrations. Academic Press, Inc., 125 East 23d Street, New York 10, N. Y.

Professor Szent-Györgyi's work on the theory of muscle contraction has attracted world wide attention. In a previous book he gave some of the reports from his laboratory in the form of a more or less direct laboratory report. The present volume based on lectures at the University of Birmingham and the Massachusetts Institute of Technology gives these data in the form of a series of topics which logically take the reader through the reasoning behind the author's theory of muscle contraction. He starts out with the histological molecular and electronic structure of muscle, continues with what one might call the physiology of myosin, actin and actomyosin and in the fourth lecture applies these biochemical and structural data to the physiology of muscle contraction. The relation between actomyosin and its parts, and adenosine triphosphate have, largely due to the author's investigations, taken a more and more conspicuous place in our thinking about muscular contraction. The author discusses the difference between these materials in vitro and in vivo, that is, in the muscle fiber. Particularly important are his conclusions regarding energy exchange in contraction and relaxation. The road from the simple observation of the contracting muscle to the goal of an explanation of its underlying mechanism has been a particularly difficult one. Violent arguments have occurred in the field of muscle physiology, due largely to the extreme activity in this field. Also the importance of the phenomena of muscle physiology has a basic importance far above their own narrow field. The study of muscle metabolism and the energy transformations during muscle contraction and relaxation come closer to the physiology of the basic processes of living matter than almost any other studies in the field of physiology. Truly then a study on muscle brings us close to the problem of the nature of life.

TWENTIETH CENTURY SPEECH AND VOICE CORRECTION. Edited by *Emil Froeschels,* M.D., President, International Society for Logopedics and Phoniatrics; President, New York Society for Speech and Voice Therapy. Fabrikoid. Price, $6.00. Pp. 321. The Philosophical Library, Inc., 15 East 40th Street, New York, N. Y., 1948.

This book brings together modern information on speech and voice correction in 22 chapters by 19 different authors. For teaching purposes it starts with a review of anatomy and physiology. The clinical and pathologic findings of the various types of speech disorders are then described. The therapeutic measures recommended are presented in considerable detail, although usually in outline form. There is a minimum of theoretical discussion or reference to the literature except in a few chapters. All interested in this field should find this an excellent small reference text representing the opinions of present-day authorities.

BRAIN AND INTELLIGENCE: A QUANTITATIVE STUDY OF THE FRONTAL LOBES. By *Ward C. Halstead,* Ph.D., Professor of Experimental Psychology, Division of Psychiatry, Department of Medicine, University of Chicago. Cloth. Price, $6.00. Pp. 206 with 27 Illustrations. University of Chicago Press, Chicago 37, 1947.

This monograph brings together the results of twelve years of investigation by the author and his collaborators under the auspices of the Otto Sprague Institute and the Division of Psychiatry at the University of Chicago. The author has had the privilege of much consultation with other members of the staff of the University of Chicago. A battery of 27 neuropsychologic tests has been used on 237 test individuals. From this the author has developed a four factor description of biological intelligence. The author has proceeded to examine next the extent to which these factors are represented in the brain. An impairment index has been developed as a result of these ex-

periments. Individuals with frontal lobe damage have a high impairment index. There is no relationship between the extent of the lesion and the degree of impairment. The book contains a wealth of challenging data. The concept of biologic intelligence as a basic function of the brain with a maximal representation in the frontal lobes is a particularly important conclusion. The physiatrist who deals with the after effects of brain lesions should find this monograph a particularly worthwhile addition to his library.

AIR PUBLICATION 1269 B. 1ST EDITION. 1946. Air Ministry Handbook of Preventive Medicine. Crown Copyright Reserved. Cloth. Price, 7s, 6d net. Pp. 213, with 42 illustrations. His Majesty's Stationery Office, London, 1948.

This volume presents in concise form the elementary factors of preventive medicine, the knowledge of which should enable medical officers to advise their commanders of the measures necessary to protect the personnel under their care, as far as possible, against communicable disease and any defects of habit or environment which may impair their vitality, as well as measures to improve their efficiency even beyond what is accepted as normal. Its seven chapters are: Personal hygiene, water, food and nutrition, environment, conservancy, communicable diseases, disinfection and disinfestation. The foreword states that medical recommendations may clash with strategic and tactical considerations and may therefore be impossible to fulfill. For instance, the ruthless removal of a native village from the outskirts of a military camp, however desirable from the view point of the hygienist, may have to be renounced for political reasons. The only suitable ground for a landing strip may be alongside a malarial marsh. Compromise is often inevitable. It may not be possible to ensure an absolute minimum of avoidable disease, but the most strenuous efforts must always be made to reduce ill-health, and sub-health, to the lowest possible level, by applying the principles of preventive medicine which are set out in this publication.

DISEASES OF THE ADRENALS. By *Louis J. Soffer,* M.D., Adjunct Attending Physician, the Mount Sinai Hospital, New York City. Cloth. Pp. 304, with 42 illustrations and 2 colored plates. Price, $5.50. Lea & Febiger, 600 S. Washington Sq., Philadelphia 6, 1946.

In this volume are combined the recent advances in the knowledge of adrenal physiology together with the results of its clinical application in the treatment of adrenal disease. The preliminary chapters deal with the diagnostic technics used in studying adrenal cortical function and an extensive review of physiologic studies of adrenal function as a basis for clinical application. The research on adrenal cortical function in relation to other systems of the body is correlated with and applied to the problems arising with adrenal disease. The clinical aspects of adrenal disease are based largely on the experience of the Mt. Sinai group with frequent reference to experience in other centers. Adrenal cortical insufficiency is discussed thoroughly from the standpoint of pathologic physiology, symptomatology and specific treatment. In discussing adrenal cortical tumors, an attempt is made to differentiate the adrenogenital syndrome due to abnormal production of sex hormones from the disturbance of metabolic hormones that produces Cushing's syndrome. The rare tumors of the adrenal medulla are discussed briefly. Typical case histories are used frequently to emphasize clinical application. This combination of the recent knowledge of adrenal physiology together with practical clinical experience should be of great value to all internists and students of endocrinology.

INTRODUCTION TO PHYSIOLOGY. By *W. H. Newton,* D.Sc., M.D., Holt Professor of Physiology, The University, Liverpool. Cloth. Price, $2.50. Pp. 284 with 113 figures. Williams & Wilkins, Mount Royal and Guilford Aves., Baltimore 2, Md., 1948.

This small volume is an excellent introduction to physiology. It would be a useful aid to a larger text for student nurses, physical therapists and students in physical education. The text is naturally limited but is accurate, well presented with excellent examples given to make the subject clear. The book does not pretend to cover the whole of physiology at the elementary level. It is an introduction to the subject intended to culcate a physiologic outlook. The book is recommended as a supplementary text for student physical therapists and nurses.

LABORATORY EXPERIMENTS IN PHYSIOLOGY. By *W. D. Zoethout,* Ph.D. Fourth edition. Fabrikoid. Price, $3.00. Pp. 263, with 97 illustrations. C. V. Mosby Co., 3207 Washington Blvd., St. Louis 3, 1948.

For those who are looking for a laboratory manual of physiologic experiments this volume will be welcome. Its popularity is proven by this presentation of a fourth edition. The book is divided into two parts part one deals with physiologic experiments; and part two with the rudiments of physiologic chemistry. The author states that he has written for the student whose alloted time to the subject is somewhat limited. The experiments are clearly outlined and well illustrated. In part one the chapters are devoted to apparatus, muscle contractility, conductivity of nerves, the central nervous system, blood, circulation, respiration, sense organs, ailimentary canal, urine and sweat secretion. In part two chapters include carbohydrates, fats, protein, digestion and urine. There is also a useful appendix. There are two hundred and sixty-two experiments listed. This book should prove especially useful to teachers of physiology who are teaching in courses of physical therapy.

SOURCE BOOK OF ORTHOPEDICS. By *Edgar M. Bick,* M.A., M.D., F.A.C.S., Dipl. Orth. Surg., Associate Orthopedic Surgeon, The Mount Sinai Hospital, New York; Fellow American Academy Orthopedic Surgeons; Fellow in Orthopedic Surgery, New York Academy of Medicine; one time Regional Consultant Orthopedic Surgeon (Army), European Theatre of Operation. Second edition. Cloth. Price, $8.00. Pp. 540. The Williams & Wilkins Company, Mt. Royal and Guilford Avenues, Baltimore 2, Maryland, 1948.

Medical students, orthopedic surgeons, research workers in orthopedics and physiatrists should welcome this valuable reference text. The first part, consisting of 66 pages, deals with the ancient background of orthopedics. The origin of contemporary knowledge and practice is divided by subjects into separate chapters. These include physiology, pathology, bone surgery, fractures, joint surgery, hip, spine and foot conditions, neuromuscular disorders, and physical methods of treatment. Of course, a book of this size cannot be complete and readers especially interested in a small area in the field may note omissions, as for instance in the case of physical medicine. On the whole, a very careful selection of material has been made and the array of proper names connected with orthopedic procedures should be less confusing to the student or physician who has access to this valuable book.

COMMUNAL SICK-CARE IN THE GERMAN GHETTO. By *Jacob R. Marcus,* Ph.D.; *Adolph S. Ochs,* Professor of Jewish History, Hebrew Union College. Cloth. Price, $4.00. Pp. 335. The Hebrew Union College Press, Cincinnati, Ohio, 1947.

This interesting work describes the well organized Jewish Communal care of the sick in German and the Hapsburg lands in the period from about 1500 to 1800, the age of political disability and social degradation for the German Jew. At first the community concerned itself both with the spiritual and the physical health and welfare of its members in almost every detail. In many communities, the communal care of the sick was supplemented, if not taken over completely, by a Holy Brotherhood (Hebra Kaddisha). The one basic institution which both fraternity and community employed in their attempt to care for the sick is the hospital. The Jewish hospital at first only consisted of one room, at the most a series of rooms in a building, occasionally a house or a group of small buildings, in which itinerant impoverished sick people and lying-in women were housed. Later the community became increasingly conscious of the fact that the hospital-hospice was altogether inadequate, but it was only in the last two decades of the eighteenth century, under the influence of a widespread European movement to improve hospitalization, that the Jews also attempted to change the age-old hekdesh or xenodochium into a modern hospital. In the course of the next century — it took almost a century — the modern Jewish hospital was finally created. It ceased to be a shelter house for the impoverished, and for the refugee sick; and became an institution devoted solely to the sick, efficiently administered by competent technicians, staffed by scientifically trained physicians and surgeons, and patronized by both rich and poor. A number of appendices to the volume present cognate topics, as folk medicine and spiritual medicine, "The Spiritual care of the very sick and the dying by the Holy Brothers," "Care of the insane," etc. There is also appended a most extensive Hebrew and Judaeo-German bibliography. The publication of this memorial was made possible by an endowment by Dr. David Philipson of Cincinnati.

PLAGUE. LAENNEC (1782-1826) INVENTOR OF THE STETESCOPE AND FATHER OF MODERN MEDICINE. By *Arthur N. Foxe,* M.D. Cloth. Price, $2.50. Pp. 122 with 1 illustration. The Hobson Book Press, 52 Vanderbilt Avenue, New York 17, N. Y., 1947.

The title of this unusual volume was taken from the colloquial term of tuberculosis "the white plague." Its contents are a romanticised narrative of Laennec's life, beginning with early childhood in Brittany, the enchanting province of mystery and tradition and his moving to Nantes, his inspiration by the sights of this seaport; then follows an account of the bloody years of the Revolution, the exciting years of the civil war, the resumption of his interrupted schooling, the decision to become a physician, and again the turmoil of the days of Napoleon with renewed civil warring. A new chapter comes with his moving to Paris to complete his medical education; the circumstances of his studies and the personalities of his medical teachers are vividly portrayed. He studies arduously and is a brilliant scholar but already carries the seeds of the "white plague" in his chest. With short periods of relaxation he keeps on studying, paying little attention to the financial aspect of practice and becomes increasingly dissatisfied with poor treatment results due to poor basic diagnosis. He is elevated to clinical directorship in a large government hospital and works tirelessly with a large clinical material. In examining the chests of the cardiacs and the tuberculous one day a sudden inspiration makes him listen along a rolled up paper cylinder. A vast symphony of sounds struck with deafening power upon his ears through this primitive stethoscope. He spends the next three years in analyzing these sounds and correlating them to the clinical and pathologic observations. In 1879 his monumental volume "Mediate Auscultation, a Treatise on the Diagnosis of the Diseases of the Lungs and Heart, Founded Principally on This New Means of Exploration," appears. It brings international fame and recognition, but his own strength gradually ebbs away. Seven years later he dies of tuberculosis, the early recognition and clinical management of which disease his own observations had so materially advanced. The author of this volume is an outstanding psychiatrist and has written extensively in his own field. Readers in all walks of life should find this book quite interesting and inspiring.

DIAGNOSTIC SIGNS, REFLEXES, AND SNYDROMES. Standardized by *William Egbert Robertson,* M.D., F.A.C.P., Emeritus Professor of Medicine, Temple University; Active Consultant, Medical Division, Philadelphia General Hospital; Visiting Physician, St. Luke's and Children's Hospital; Medical Consultant, Northeastern Hospital; and Harold F. Robertson, B.S., M.D., F.A.C.P., Associate in Medicine, University of Pennsylvania; Medical Chief to the Neuropsychiatric Department, Philadelphia General Hospital. Third edition. Fabrikoid. Price, $4.50. Pp. 376 with no illustrations. F. A. Davis Company, Washington Square, Philadelphia, Pa., 1947.

An encyclopedia, like a dictionary, needs constant revising to keep in date. Realizing this, the authors have brought out the third edition of this compilation of clinical signs and syndromes. The book is probably the only reference available under one cover in which such material has been presented. All signs, reflexes, syndromes are listed alphabetically under names of the various conditions, diseases, parts, organs, and men who have described them. Where possible, the original source is given. The first edition represented a great effort and now the authors have endeavored to include all the newer conditions, e. g., Keller's atomic bomb syndrome. The book is a worthwhile addition as a library reference.

THE REHABILITATION OF SPEECH. Book One: THE PATHOLOGY OF SPEECH AND THE RATIONALE OF ITS REHABILITATION. By *Robert West,* Professor of Speech Pathology, University of Wisconsin. Book Two: REMEDIAL PRINCIPLES. By *Lou Kennedy,* Associate Professor of Speech, Louisiana State University; and *Anna Carr,* Clinical Adviser in Speech, State Teachers College, Milwaukee; with a chapter by Ollie L. Backus, Assistant Professor of Speech, University of Michigan. Revised Edition. Fabrikoid. Price, $5.00. Pp. 650. Harper & Brothers, 49 E. 33rd Street, New York, 1947.

Students and technicians in the field of speech defects and their treatment should find this a very adequate reference work. The first half of the text written by the senior author takes up the diagnosis of various disorders together with known pathologic mechanisms and the rationale of treatment. The second half by the two junior authors deals with the details of therapeutic procedures. Additional material includes illustrative case histories, appendices containing various testing methods, and other useful data in table form. There is also a glossary and a good collection of figures, line drawings and photographs. This book is highly recommended as a practical, well written, up to date textbook

NOTICE TO CONGRESS MEMBERS

Please take notice that at the last annual business meeting of the Congress, Sept. 8, 1948, in Washington, D. C., Section 3, Chapter 1, "Dues and Assessments" of the By-Laws was amended and, in part, reads as follows: "Membership dues in the Congress shall be payable January 1 annually and shall be in such sum as the Board of Governors shall determine, provided that notice of the Board's determination of dues for the ensuing year shall be published in either the October or November issue of the ARCHIVES OF PHYSICAL MEDICINE. The dues so determined by the Board shall be net dues accruing to the Congress and shall be transmitted to the Congress regardless of the amount of dues that may be collected by a society affiliated with the Congress in accordance with any arrangement that may be entered into between the Congress and the affiliated society for the collection and transmission of dues."

In accordance with this amendment the Board of Governors set the amount of such dues for 1949 as Fifteen Dollars ($15.00).

PHYSICAL MEDICINE ABSTRACTS

Microwave Radiations. Heating of Human and Animal Tissues by Means of High Frequency Current with Wavelength of Twelve Centimeters (The Microtherm). Stafford L. Osborne, and Jesse N. Frederick.

J. A. M. A. 137:1036 (July 17) 1948.

Microwave (radar) radiations were applied to the thighs of dogs, and temperature measurements made subcutaneously and at ½ inch (1.27 cm.) intervals to a depth of 2 inches (5.08 cm.). Following exposure to high frequency energy the maximum temperature was observed in the subcutaneous level and decreasing temperatures were found with increasing depth. The average temperature at a depth of 2 inches (5.08 cm.) in ten experiments using the 6 inch (15.24 cm.) hemispherical director at a spacing of 1 inch (2.54 cm.) from the skin surface was 104.1 F. (40.1 C.).

In seven acute experiments on dogs the eye was exposed to microwave radiations. The average temperature of the vitreous body following microwave treatment was 105.8 F. (41 C.). One animal received a series of six treatments over a period of three weeks. There was no evidence of damage to the eyes or contiguous tissues.

Six experiments were performed in which the frontal sinus of the dog was exposed to microwave radiations. The average of the temperatures of the frontal sinus following exposure to the microwave was 105 F. (40.6 C.).

In twenty-four experiments on human subjects the thigh was exposed to microwave radiation. The average temperature at a depth of approximately 2 inches (5.08 cm.) immediately following microwave irradiation was 104.2 F. (40.1 C.). One small superficial blister was produced. By the tenth day the blister had disappeared. The treatments were comfortable to the patients, and a minimum of erythema was noted. Microwave treatment should be applied cautiously because the minimum of erythema and discomfort to the patient gives the operator less warning of overheating. The limitations by localized heating by this method have been indicated.

The Treatment of Infantile Paralysis During the Acute Stage. Philip Lewin.

J. Indiana M. A. 41:908 (Sept.) 1948.

As soon as the diagnosis of infantile paralysis is proved or strongly suspected treatment should be started. Rest is the one great essential in the immediate care. Extremities should be kept warm. Gentle passive exercises are given, but never to the point of pain. Any recognized type of splint which will maintain neutral positions can be used. The patient must be kept in bed, with physical and mental quiet. To preserve rigidity and prevent sagging, several boards or a wood frame may be placed under one or two mattresses. Warm sea baths alleviate muscle and nerve pain. In some instances they may be started cautiously within seven days after the onset of the disease. Attention should be directed to the prevention of deformities by means of rest in proper positions, with constant supervision of the most minute details. The less patients are handled in the early stages, the better the results will be. The majority of patients are kept off their feet from ten to twelve months before they are allowed to attempt to stand or walk even the support of braces and crutches. If, however, a patient is very slightly affected, his activities will depend largely on the return of power to the muscles of his trunk, pelvis and lower extremities. He would probably be kept off his feet for at least six months. Overuse of an affected limb is harmful.

Muscle training consists in aiding the patient to perform a certain movement, in the hope of stimulating an impulse for the movement from the brain to the weakened or paralyzed muscle. Underwater treatment has been an important advance in handling poliomyelitis patients. Light massage, if given by a person especially trained in the aftercare of infantile paralysis, is valuable.

Fibrositis. James Cyriax.

Brit. M. J. 4569:251 (July 31) 1948.

Controversy has gone on for many years about the nature and identity of the different disorders included by common consent under the heading of primary fibrositis. The existence of fibrositis is affirmed by most clinicians, denied by most pathologists, but in the absence of an alternative explanation for the symptoms and signs purely negative views have carried little weight.

The underlying principle is simple: to secure reduction of the intraarticular displacement causing the symptoms.

Whether the patient has pain in the neck, the scapular area, or the upper limb; a few sessions of manipulation seldom fail to secure reduction. In some simple cases involving the thorax one manipulation may result in full reduction; but eventual relapse is common. With difficult cases it is easy to make the patient worse. If attempted manipulative reduction, even during traction, fails, rest in bed is indicated. With backache recovery follows a few sessions of attempted manipulative reduction in about half of all cases. Rest in bed relieves some others but may lead to aggravation. Two-thirds of all cases of lumbago are considerably, one-third fully, relieved by manipulation.

Manipulation is particularly apt to be effective

in sciatica in the elderly; in patients under the age of fifty it is likely to succeed in only one case in four.

Traumatic fibrositis results from overuse or a single strain. Perhaps the best example is a tennis elbow. Infectious fibrositis is characterized by fever, severe pain in the abdominal and thoracic muscles and speedy recovery. Parastic fibrositis comes on some ten days after eating infected pork. Active contraction of the affected muscle increases the pain.

Primary fibrositis, both local and generalized, is an imaginary disease. The symptoms erroneously ascribed to this condition are all the result of articular disorders (largely internal derangement) at the spinal joints. Secondary fibrositis (traumatic, infectious and parasitic) is a real entity.

Urticaria Caused by Heat, Exertion and Excitement. Report on Twenty-Two Cases Among American Soldiers in Japan. Harry Sigel.

Arch. Dermat. & Syph. 57:204 (Feb.) 1948.

Urticaria caused by heat, exertion and excitement is an uncommon dermatologic disease.

Twenty-two patients with urticaria caused by heat, exertion and excitement were observed among American soldiers in Japan. The large number seen is considered to be unusual. Before arriving in Japan, which is in the temperate zone and is decidedly cool in the autumn, all the patients (except the one from Florida) had spent the previous summer months in the Philippine Islands, where the weather is hot. This represented a rather abrupt drop in climatic temperature of their environment and is probably of etiologic significance except in the 3 patients who already had symptoms before leaving the Philippine Islands.

The eruption was characterized by pinhead-sized wheals, with or without erythema, and accompanied with urgent itching, prickling and burning sensations. Intradermal tests with histamine phosphate in a dilution of 1 to 1,000 showed no evidence of histamine sensitivity. Gastric analysis before and during attacks showed no evidence of abnormal production of histamine.

Treatment in general was unsatisfactory. Histamine phosphate desensitization seemed to be of some value in a few cases. Symptoms could be relieved with any cooling agent. Patients with milder symptoms improved with any form of treatment, while most of the patients with severe symptoms remained resistant to treatment.

An Ideal Hospital for Paraplegic Patients. L. W. Freeman.

Mil. Surgeon 103:219 (Sept.) 1948.

A practical solution to the establishment of a large hospital center for the exclusive care of patients with spinal cord injuries is presented. Every effort has been made to approach the ideal in every respect while still maintaining an attitude of practicality. Many of the solutions are borrowed; others, such as the overhead bars and the lavatory adaptations, are believed to be original with this group. The hydrotherapy ward could also be classed original.

Causalgia Following Gunshot Injuries of Nerves. Role of Emotional Stimuli and Surgical Cure Through Interruption of Diencephalic Efferent Discharge by Sympathectomy. James C. White; William W. Heroy, and Edmund N. Goodman.

Ann. Surg. 128:161 (Aug.) 1948.

Major causalgia follows partial injury of the mixed peripheral nerve trunks incurred in penetrating wounds with a rate of incidence somewhat under 5 per cent. The pain is aggravated to an unbearable degree by factors which increase the sympathetic discharge from the hypothalamic centers, thermal and psychic stimuli. While it may disappear with complete regeneration of the injured nerve, this process is at best so slow that the patient is liable to become addicted to morphine, suffer serious personality changes and develop irreparable trophic disturbances in his bones, joints and soft tissues. Interruption of the sympathetic outflow, preferably by preganglionic sympathectomy, is an effective method of treatment and should be performed at an early date. Preliminary chemical blocking of the sympathetic rami and ganglia by injection of procaine is a valuable diagnostic test, particularly in atypical cases. Repeated paravertebral injections have been reported to give lasting relief in some cases, but they have not been effective in our patients. Sympathectomy in the hands of the authors has resulted in consistent relief of the burning causalgic pain. After operation eight patients had no further complaints of any sort. On careful cross-questioning, five had some residual paresthesia and hyperesthesia in the area of recovering cutaneous innervation. This in no way resembled the former causalgic syndrome and was identical with the usual subjective sensations that accompany nerve regeneration. It was severe enough to retard rehabilitation, in only a single patient.

It is the opinion of the authors that relief of burning pain following denervation is due to elimination of the efferent sympathetic discharge from the hypothalamic centers rather than to any interruption of pain fibers. There is no good evidence for the existence of centrally conducting sympathetic axones in the peripheral nerves. Furthermore, the suffering of causalgia is relieved under circumstances in which sympathetic tone is reduced, a quiet, warm environment, ingestion of alcohol, sleep, and febrile states. Recently, reported work on experimental animals suggests that there may be a short-circuiting effect in the area of the injured peripheral nerve which permits direct irritation of sensory afferent fibers by efferent sympathetic impulses.

Thirteen cases are described which have been treated at a Naval Hospital. All were relieved of their unbearable pain and the resultant effect on their psychological status and resistance to rehabilitation was dramatic. While the period of

follow-up has been usually less than a year, there is no reason to suppose that recurrent complications will occur.

The Effect of Exercise on the Electrocardiogram (Master Two Step Test) in the Diagnosis of Coronary Insufficiency. David Unterman, and Arthur C. DeGraff.

Am. J. Med. Sci. 215:671 (June) 1948.

The Master "two-step" exercise test was performed in 163 subjects including controls, patients with heart disease and patients convalescing from acute illness. The electrocardiographic changes following exercise were regarded as significant in 40.7 per cent of 59 patients with coronary disease and in 48.3 per cent of 31 patients with anginal syndrome. No serious untoward reactions to exercise were noted. The electrocardiographic response was positive in 7 of 10 patients who experienced anginal syndrome during the test. A small number of patients with negative "standard" test showed a positive test when the "souble standard" exercise was performed. The test provides a means of determining coronary insufficiency when other means are not available, although it does not do so in all cases. The practical value of the test appears to be limited by a high incidence of negative responses. The theoretical aspects of the test are discussed. The possible influence of different electrocardiographic technics and criteria as well as the influence of food, digitalis and recent acute illness are considered.

Early Ambulation: Clinical Results and Frequencies. Karl A. Meyer; Donald D. Kozoll, and Nicholas Capos.

Minnesota Med. 31:883 (Aug.) 1948.

No discussion of early ambulation would be complete without a consideration of possible contraindications. Failure to recognize that not all patients can be ambulated early has probably led to the abuse and disuse of this program in the past. Each patient should be individually evaluated and if any of the following extenuating factors are present, final judgment may well be to defer ambulation: (1) Shock — hypotension is aggravated by motion and the erect position. (2) Hemorrhage—because of the attendant shock and fear of encouraging more bleeding with motion. (3) Generalized peritonitis — because of the pain, distention, and sepsis. (4) Unrelieved intestinal obstruction — because of the distention and the resultant tension on wounds. (5) Pulmonary infection — because of tachycardia, dyspnea, toxemia. (6) Wound evisceration or extensive wound infection — tensile strength of wound is diminished. (7) Severe toxic states — irrational states such as are seen in thyroid crisis, sepsis. (8) Cardiovascular complications — ambulation would add to the load of a burdened myocardium. (9) Extreme debility — nutritional deficiencies. (10) Severe anemia — cerebral anemia aggravated in the erect posture.

The postoperative complications of 500 surgical patients after the performance of one or five standard surgical procedures (gastric resection, colon resection, cholecystectomy, hysterectomy and herniorrhaphy) were studied in relation to early or late ambulation. There was a total of ninety-eight complications among 500 patients; twenty-eight of the complications occurred in the 250 patients ambulation early and seventy in the other half ambulatory late, 11.2 per cent and 28.0 per cent, respectively. There was a total of thirteen deaths (included in the ninety-eight complications), of which all but one occurred in the group with prolonged bed rest. Pneumonia not only occurred more frequently in the late risers but also was more often fatal. Postoperative wound infections, thrombophlebitis and distention showed a decline with early ambulation, whereas pulmonary atelectasis and cystitis did not. A significantly shortened period of hospitalization was seen for each of the procedures when followed by early ambulation. A detailed consideration of the prerequisites for early ambulation, its advantages and contraindications is presented.

Traumatic Dislocation of the Hip Joint. Review of One Hundred and One Dislocations. J. R. Armstrong.

J. Bone & Joint Surg. 30-B:430 (Aug.) 1948.

The patients reviewed in this paper received all or part of their treatment in the orthopedic centers of the Royal Air Force between June, 1940 and June, 1945. More than half of them were admitted to one of the centers directly after injury and others were seen within the first few days. In many, however, initial treatment had been carried out elsewhere, often under circumstances of extreme difficulty, and several months had sometimes elapsed before the patient reached this country. Only in one case did myositis ossificans develop, and that was the only case treated by "massage and movements" throughout the first ten weeks after injury.

Infections of the Hand. J. B. Loudon; J. D. Miniero, and J. C. Scott.

J. Bone & Joint Surg. 30-B:413 (Aug.) 1948.

The authors have been impressed by the large number of hands which despite treatment were damaged beyond repair, both functionally and cosmetically. This was sometimes due to neglect in treatment, but in other cases it was the inevitable result even after the early application of all methods in current use.

Regarding postoperative treatment, elevation and immobilization should continue until swelling has disappeared and the wound is healed, usually within ten days. Sutures should not be removed in less than seven days. Gentle use of the digit is encouraged as soon as the wound is healed, even before removal of the sutures. Full movements were regained in all cases by ordinary use of the hand, except in the case of two patients who needed physical therapy.

Particular care is necessary when there is necrosed skin. As soon as the wound is clean and granulating, skin grafting should be carried out under local anesthesia. Pinch grafts, taken from the inner surfaces of the arm, have been used. Immobilization in plaster was continued for another eight to ten days. Intensive active exercises were then started.

Corrective Physical Rehabilitation — An Effective Approach. J. L. Rudd; Reubin J. Margolin, and Charles L. Rose.

Mil. Surgeon **103**:125 (Aug.) 1948.

This article describes the special methods used in a physical rehabilitation setting, which proved to be more effective than a routinized conventional approach. Ingredients in this program were: 1 — motivation through patient participation; 2 — informality; 3 — free expression of patient including expression of hostility and resistance; 4 — use of personal relationship factors and 5 — use of imaginative and sometimes improvised material in athletic activities and dramatizations.

The general aim was to create a therapeutic atmosphere which facilitated the response of each individual within the group. Negative factors in patients' behavior were given an opportunity for expression and thus prevented from blocking maximum recovery. In a minority of cases, resistances were so deeply rooted in fears that only limited successes could be achieved. The emotional component present in the play between patient and therapist was recognized, understood and utilized. This factor of relationship, common to all disciplines allied under the aegis of rehabilitation, points to the need of an integrated program, from which the individual patient can receive optimum benefit.

Value of Physical Therapy as an Adjunct for the Aged. Louis Feldman.

Med. Record **161**:418 (Aug.) 1948.

At the beginning of the twentieth century about 5 per cent of our population were over sixty-five and 18 per cent were forty-five years of age or older; today 6.8 per cent are over sixty-five, and 27 per cent are forty-five years of age or older. In the United States now there are actually 6,000,000 more persons who are sixty-five years of age or older than there were in 1900 and it is estimated that by 1980, the total number of those in this age group will be 22,000,000.

Physical therapy has been proven a valuable adjunct to medicine and surgery in the diagnosis and treatment of disease and injury at all ages. If all precautions are taken with proper understanding of the physiopathologic changes, underlying the conditions in this select group, and the correct diagnosis and indication for treatment is present, favorable results shall be attained. It is important to maintain mobility and preserve circulatory balance and to instill a sense of well being and a zest for living. Physical medicine is a great aid in the relief of pain and disability in their mental and physical rehabilitation.

Prostatitis: Especially as It Relates to Cause, Treatment and Significance. Roy B. Henline.

Nebraska M. J. **33**:266 (Aug.) 1948.

Acute prostatitis is best treated by complete bed rest for all febrile cases and the avoidance of foods which irritate the urinary tract. Sexual excitation should be avoided and all local treatment, such as urethral or bladder irrigations and rectal manipulation, should be discontinued. Heat is beneficial and may be obtained by hot sitz baths. The bowels should be kept well open to avoid the pressure of a hard stool against the prostate. Only the most gentle palpation should be done to diagnose the development of a prostatic abscess. Once the diagnosis of chronic prostatitis has been established, massage of the prostate by the rectum is the most important single measure to be employed in its treatment.

Use of the Traxator in Nonarticular Rheumatism: A Clinical Assessment. Francis Bach.

Brit. J. Phys. Med. **11**:110 (July-Aug.) 1948.

The Traxator is a machine used for massage. It was invented in Denmark during World War II. It employs the principle of "cupping" and a vacuum is obtained by means of an electric vacuum pump, attached by a flexible rubber tube to suitably shaped applicators, which are placed over the area to be massaged. The applicators are made of light aluminum alloy; when they are used, liquid paraffin is rubbed on the skin to make an air-tight seal.

The machine should be used only by qualified persons who have been trained in its use. There is no contraindication to the use, at the same time, of general and medical and physical treatments. The clinical results, in the small series of patients treated by this method, justify further study, a more extensive clinical trial and the present use of the machine in clinical practice.

Rehabilitation of Fractures. J. J. R. Duthrie; J. G. Maclead, and R. J. G. Sinclair.

Brit. J. Surg. **35**:414 (April) 1948.

The methods used in the rehabilitation of service cases following fractures are described. An analysis of the results obtained in 3121 fractures is presented, with special reference to the duration of treatment and the degree of residual disability. Attention is drawn to the singular lack in the literature of reasonably accurate estimates of these factors. It is hoped that the figures may be of value in the assessment of prognosis. The figures presented in this paper were collected while the authors were serving as specialists in physical medicine in Scottish Command.